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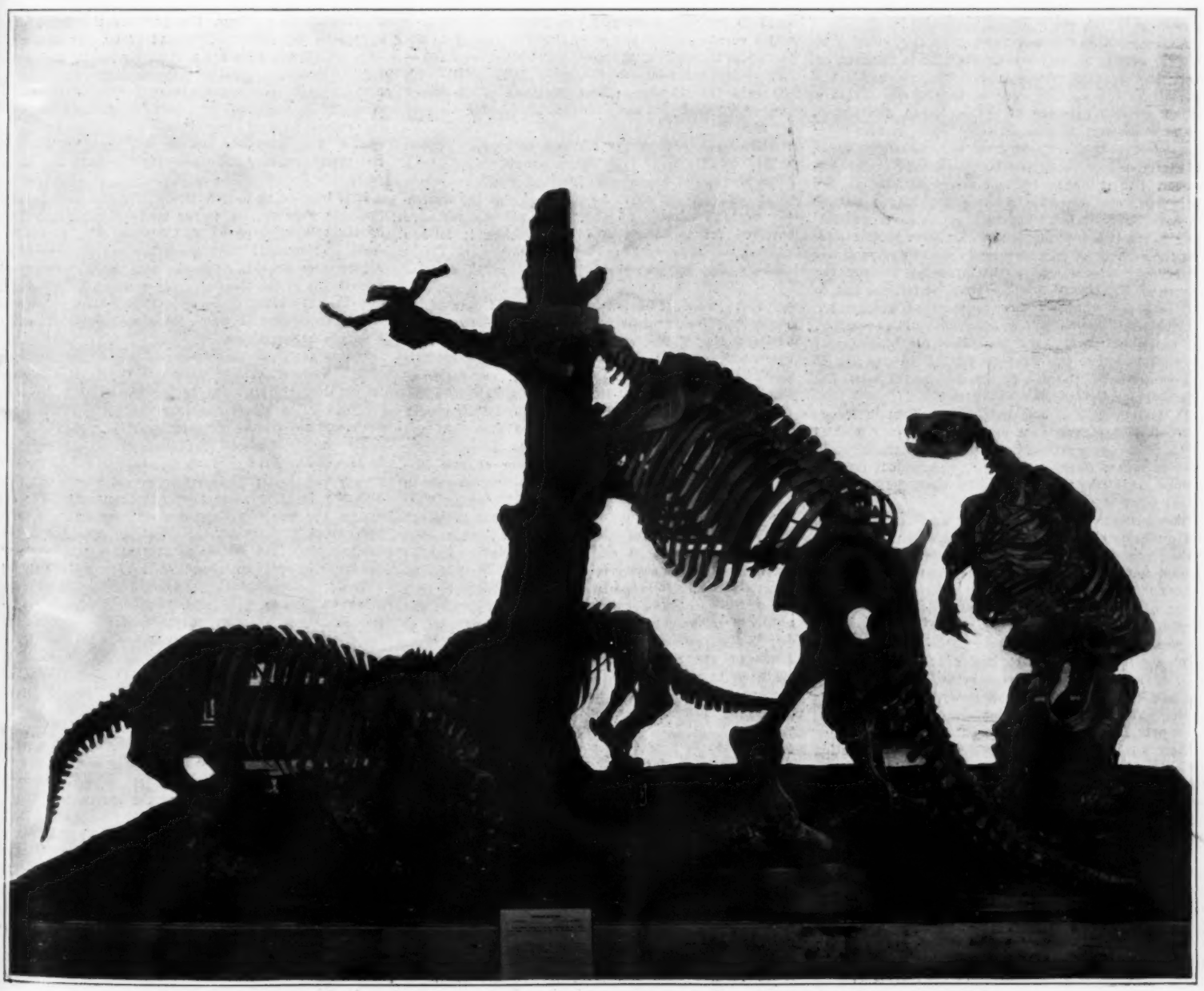
A New Ground Sloth Group

By W. L. Beasley.

In the new group of four fossil skeletons representing the Ground Sloth, just mounted at the Museum of Natural History, New York, Prof. Henry Fairfield Osborn has made a noteworthy and realistic exhibit of these remarkable extinct animals of South America. The skeletons are among the fine specimens of the famous Cope collection purchased by a number of trustees of the museum. Their remains were dug up from the vast loess or loam deposit which underlies the Pampas of the Argentine, known as the Pampean formation. The skeletons represent two genera of these animals, Lestondon and Mylodon. As the food of the Ground Sloths was principally the foliage, leaves, twigs, etc., that grew on the primeval trees, these bulky animals were fittingly adapted in structure to the process of digging, uprooting and felling trees. The animals possessed powerful claws, massive hind quarters and colossal strength. The group, as here pictured, is designed to illustrate the theory of their habits. The largest skeleton, Lestondon, shown standing on his legs, is endeavoring to reach up and drag down branches of the tree. One of the Mylodons is busily digging and tearing at the roots to loosen and break them so as to help his big mate to uproot and pull the tree down. A third animal is coming around the base of the tree to assist in the digging operations, with a fourth standing a short distance away ready to add his weight to drag down the branches when they are brought within reach. The large standing skeleton is about 15 feet in length. The Ground Sloths were probably larger than a big Indian Rhino. The anatomy of these creatures indicates a terestrial mode of life. Their teeth were adapted to the bruising and crushing of leaves and twigs, the structure of the jaws and skull and arrangement of the nerve channels indicate loose, flexible lips and a long prehensile tongue adapted to browsing. The long loose-jointed fore limbs enabled the animal to lay hold of branches or small trees and drag them down within reach, and the powerful claws enabled it to dig around the roots of larger trees and loosen them. The massive hind quarters and tail gave the necessary weight and fulcrum to pull down the trees when loosened, in order to feed upon the upper foliage thus brought within its reach. One of the skeletons in the group has a fracture of the bone on the hind leg very likely due to a tree falling upon it in the course of its lumbering operations. As to their appearance, it is known that the Mylodons were covered with a thick coat of furry hair, somewhat like the brown bears of Alaska. Their thick skin, in which were buried numerous small nodules of bone, made an effective defense against cold and the attacks from various carnivorous beasts of prey living at that period. The Ground Sloths flourished during the early part of the Age of Man. Their nearest modern relatives are the Tree Sloths and Ant Eaters of to-day. The Ground Sloth group is considered one of the most realistic that has yet been attempted in the mounting of fossil skeletons in this country. This has been accomplished by the new free hand method of mounting, whereby the old style upright steel rods ordinarily used have been eliminated, thereby adding much to the effectiveness of the mount. This method, devised in 1904 by Mr. Albert Thompson of the Palæontological department, is here applied for the first time to the mounting of large skeletons. Each skeleton is supported by a



THE NEW GROUND SLOTH GROUP AT THE MUSEUM OF NATURAL HISTORY, NEW YORK.

series of steel rods running along the limbs and other parts, fitted snugly to the bone and not at all conspicuous. In fact, one of the unique advantages, both from a technical and artistic standpoint, over the old method is that the heavy rod supports are concealed, thus making a very handsome mount. By this new method every bone can be detached for study, to be cast, or for any other purpose. This was not possible in the old rigid mounts. Prof. Osborn and Dr. W. D. Matthews and the scientific staff criticized and discussed the arrangement of the group until an adjustment was reached which seemed to represent the most characteristic poses and habits of these animals. The original skeletons were then mounted by Mr. Charles Lang under the direction of Head Preparator Hermann. The missing bones were restored by Messrs. Charles and Otto Falkenbach. The group was designed by Mr. Edwin Christmas, who made the working model

Measuring the Laborer's Worth

The Application of Laboratory Methods to the Study of Labor Questions

IT is obvious that labor questions are regarded from different points of view by employers and workmen. The consideration of the expenditure of energy involved in the work will make this difference appear still more striking. Furthermore, a problem is partly solved when its data and difficulties are clearly expressed. It will be useful to show by a few examples how the consideration of the expenditure of energy can serve this double purpose.

Whether the workman is paid by the day, by the piece, or otherwise, the total sum received by him always results from the more or less rigorous consideration of these three factors; the amount of service received by the employer in the form of goods manufactured, transported, etc., the amount of energy expended by the workman, and the total time of work. It may be to the interest of both parties, although for different reasons, to shorten the working day, but the amount of service interests only the employer and the expenditure of energy interests only the workman. In other words, in the discussion in disputes about pay the workmen will employ, more or less consciously, arguments of physiological character, while the arguments of the employer will be exclusivey economical. These two classes of arguments are totally dissimilar and have no point of contact, hence it is very difficult to reach an agreement, even in the absence of class prejudice and socialistic arguments. The results reached will be contradictory according to the point of view from which the question is regarded.

An example of this is furnished by the question of pay for overtime. The human machine is fatigued by work and gradually becomes less able to satisfy the demands made upon it. Hence, as the day advances the productive capacity of the workman diminishes, while the performance of the same work becomes more and more onerous. The hourly pay, therefore, ought to diminish from hour to hour, according to the employer, but it ought to increase, according to the workman. In practice the two contracting parties agree upon a uniform hourly pay, which is satisfactory to the two opposing interests. Now, in determining the amount of pay for overtime, the workmen has a tendency to take as the basis of his demand the progressive aggravation of his sense of fatigue, and to estimate the overtime pay in accordance with the fatigue of his last hour of regular work. The employer, on the other hand, naturally takes for his base of calculation either the lessened productive capacity of the workmen at the end of the day, or, at most, the average capacity for the whole day.

D. A. Imbert, who discusses this problem in *Revue Général des Sciences* sees in this discrepancy a chief cause of the apparently unreasonable demands of workmen in regard to overtime pay. It is evident that an agreement is very difficult to reach when the two sides adopt units of measure so different.

The question of pay in general may also be made more intelligible by physiological consideration. Workmen contend that wages for work of any character should be sufficient to supply the wants of the workman and his family. Employers refuse to adopt this point of view, because of the economic consequences which would flow from it, and regard the proper pay as the equivalent in money of the service rendered. Such a definition is inexact because it gives no indication of the ratio of equivalence between work and pay. It is difficult and dangerous to attempt to fix this ratio, which is practically subject to the fluctuations of supply and demand in the labor market.

Now physiology furnishes some precise information on this subject. Let us consider the simplest case, in which the work is of a mechanical character and susceptible of exact measurement. In the work of the human or animal machine, the energy expended in the work is produced by an increase in food above the amount which the organism requires when at rest. Regarded from this physiological point of view, the proper remuneration for work can be rigorously determined, for it should correspond exactly to the cost of the extra food which the work has made necessary. In some cases this cost can be calculated, as the following example shows:

Take the case of a postman who daily travels 35 kilometers on a bicycle in a level country. If he traveled on foot the work done would be 420,000 kilogram-meters, according to Marey's experiments. Now, according to other experiments the work performed in each mile by a bicyclist is one-third of that performed in walking. The day's work of the postman, then, is 140,000 kilogram-meters. Although the human organism is not a mere machine which directly transforms heat into work, and although we do not know all of the transformations by which the potential energy of food is converted into work, it is nevertheless certain that the amount of mechanical work which can be performed is to be sought in the calorific value of the food. One hundred and forty thousand kilogram-meters of work correspond to 330 calories of heat.

Although the efficiency of the human motor, muscle, varies with the conditions of work, we shall not be far from the truth in assuming in the case of the postman, the value 1/3 for the efficiency. Hence the expenditure of 140,000 kilogram-meters of work will require the combustion of an amount of food capable of furnishing three times 330, or 990 calories.

Nearly the same value is obtained by a different and more direct method. It has been proved by numerous physiological experiments that the human organism at rest requires daily a quantity of food capable of furnishing about 2,300 calories of heat. The postman in question (for this is an actual case) kept a record of the quantity and quality of the food which he consumed during a fortnight, and from these data the average calorific value of his daily food has been calculated to be 3,200 calories. The portion of the food which corresponds to the expenditure of energy in his professional work is therefore equivalent to $3{,}200 - 2{,}300 = 900$ calories, which agrees fairly well with the value 990 calories, which obtained by the other method. Taking the mean of the two results, we may estimate that the postman, in order to perform his regular work, requires an increase of food equivalent to 945 calories per day. The postman also kept an exact account of his expense for food which amounted to 85 centimes per day. As this food was the equivalent of 3,200 calories, of which only 945 calories were required for the work of his profession, it follows that the cost of this work was $\frac{85 \times 945}{3{,}200} = 25$ centimes per day. Hence, if his salary is considered only as the physiological equivalent of the work performed, the postman should receive only 25 centimes, instead of the four francs which he actually receives daily. This view would not be adopted by even the most selfish of employers. It is evident that the pay should be something more than the monetary equivalent of the work actually done. In order to work, a man must live, and no employer can refuse to concede that the pay of the postman considered above should cover at least the 2,300 calories of food required by the man at rest in addition to the 945 calories expended in work. This view is sustained by the consideration that the work occupies many hours of the day, and that the organism of the worker requires daily rest, so that he has no time to add to his salary by other work. This concession is logically followed by others. In order to live, the workman needs not only food, but also shelter and clothing, consequently, his pay must be sufficient to pay for his food, rent, and clothing. These three items of expense seem inseparable and necessarily included in the estimate of wages, even when these are considered exclusively as remuneration for work.

Another concession should be regarded as a consequence of the first. The pay should be sufficient to provide for the support of the workman's family. Individual life is not incompatible with celibacy, but the national life is jeopardized by its extension. This, however, is a consideration on which we shall not insist as it is not strictly within the physiological and experimental field.

To resume, therefore, the salary physiologically considered should either be the monetary equivalent of the increase of food required by the occupation, in which case the pay would be ridiculously small, or it should be sufficient to cover all of the absolutely necessary expenses of life.

The application of laboratory methods may sometimes furnish data indispensable for the equitable decision of labor questions, as in the following example.

In the south of France, hundreds of women are employed in cutting up long American vine shoots with pruning shears into cuttings suitable for planting. It is essentially a mechanical operation and therefore susceptible of exact measurement. Dr. Imbert has made this measurement by applying to the shears a simple dynamometer in the form of a rubber bulb, the pressure exerted upon which is recorded on a moving strip of paper. The cuttings are classed as large or small according as their diameter is greater or less than six millimeters, and the pay is 60 centimes per thousand for the large cuttings and 50 centimes for the small ones. The women asserted that the difference of ten centimes per thousand was not sufficient. The employers granted an increase of pay and thus avoided a strike.

From the tracings obtained by a number of cutters at regular work with the registering shears, devised by Dr. Imbert, it is found that for each centime of pay the worker exerts a total effort of 110 kilograms in cutting the small stems at 50 centimes per thousand, and a total effort of 266 kilograms in cutting the large stems at 60 centimes per thousand. The pay, therefore, was by no means proportional to the work in the two cases, and these experiments furnish an incontestible proof of the justice of the women's demands.

From these numerical data it is a simple matter to calculate how much should be paid for the large cuttings, taking as a basis the sum actually paid for the small ones. Thus we find that if 50 centimes are paid for the small cuttings, the pay for the large ones should be 140 centimes, instead of 60, per thousand. This calculation does not necessarily justify a demand for 140 centimes for the large cuttings, for the employers might reply that the pay of 50 centimes per thousand for the small cuttings is really too high. But the calculations at least show the legitimacy of the claims formulated and the great discrepancy between the prices actually paid and those which should be paid.

It is interesting to note that direct and experimental methods were applied to the study of labor questions by the celebrated physicist, Coulomb, who, in his lectures at Metz, laid down the principles that the effort required from a man at steady work should not exceed four-ninths of the maximum effort which he can exert, and that the speed of working should not exceed one-third the speed with which the same movements could be made without load.

We do not know the observations or experiments on which these rules are based or the occupations to which they are applied. In the vine-cutting problem, Dr. Imbert considers the ratio four-ninths much too high, and substitutes the ratio one-fifth.

The multiplicity of the mechanical actions required in almost any kind of work appears at first to present an obstacle to complete experimental study, but this difficulty is often more apparent than real. For example, the work of moving bags and bales with a hand truck necessitates the following movements. In loading, the right foot is pressed against the axle of the truck in order to bring it to rest, the bale is tipped over on the truck with the right hand and the truck is tipped with the left hand. The work of transportation is composed of the effort required to support the handles and the effort required to propel the truck forward. All these movements can be recorded in mechanical units by means of various devices attached to the truck. The following results have been obtained from an experimental and graphical study of this kind. In transporting bags of grain, weighing 60 kilograms, to a distance of 25 meters, over a cement floor, the work performed in ten hours is equivalent to the sum of the three following parts: First, a vertical ascent of 70 meters (corresponding to the movements of the right leg and foot in stopping the truck for each loading); second, a horizontal journey of 30 kilometers against a wind of 5 meters per second (the resistance of the wind corresponds to the horizontal effort exerted); third, an aggregate effort of 18,600 kilograms exerted by the arms 30 kilograms at a time (30 kilograms is the effort exerted in loading the truck).

In the case of a strong boy, sixteen years old, the fatigue produced in the arms by a single hour of work, as measured by means of a special ergograph, was not dissipated after a complete rest of two hours.

It may sometimes be necessary to compare two tools

which can be employed indifferently in the same work. In some cases it suffices to examine the functions of respiration and circulation before and after work, in order to obtain results which will determine the choice of the tool. For example, it can be shown in this way that the transportation of the same load to the same distance, during fifteen minutes, increases the number of heart beats per minute by 14 and the number of respirations by 11½ when the work is done with a railway truck, and increases the pulse by 17½ and the respiration by 14 when a wheelbarrow is used. This proves that work with a wheelbarrow is more fatiguing than work with a truck.

The question of apprenticeship, which is occupying the attention of governments at present, may also benefit from laboratory study. A skilful workman is one who has learned to combine spontaneously those details of his work which make for increased speed, perfection, etc. But this workman is, in general, unable to teach an apprentice all of these details, which can only be determined and analyzed by a graphical record.

In the study of the work of vine cutting, Dr. Imbert obtained very different tracings of the action of the shears, according as they were used by an expert or by a beginner. These differences could not be detected by the most attentive observation of the women at work. Dr. Imbert also succeeded in reproducing both sorts of tracing by using the shears himself, and thus determined the method by which the skilled worker attains greater speed.

The graphical method is still more useful in the study of more complex acts, as in the use of a file. In this case separate records are made of the movements of the file, the pressure upon the support and the efforts exerted by each hand.

The attentive study of these records, aided in some cases by that of cinematographic photographs, will reveal the details of technique of the skilled operator and the faults of the novice. In this way, it is possible to shorten the period of apprenticeship, which is necessarily very long when the apprentice is guided only by observation and experience.

The importance of laboratory study of work has been recently officially recognized. The French minister of Public Instruction has announced that he will expend 4,000 francs this year subsidizing in researches of this character.

The Equation of Time

How Clock-Time is Related to True Solar Time

By Prof. Frederick R. Honey, Trinity College

THE interval of time which elapses between two consecutive transits of the sun's center across the meridian is the natural unit; but unfortunately it is not constant, the irregularity being due to several causes. The earth moves with a varying velocity in an elliptic orbit, and as a consequence the angle subtended at the Sun by the earth's path changes. Moreover, the earth's axis which moves into parallel positions is inclined at an angle of about 66½ degrees to the plane of the ecliptic; and its projection on this plane is not parallel to the axis of the earth's orbit.

The influence of these complex conditions which combine in varying the length of the true solar day, are illustrated in the projection of the earth on the plane of the ecliptic which shows the tilting of the axis and its relation to the axis of the earth's orbit. The earth rotates once in a sidereal day, making 366¼ rotations in the year. The equator is divided into 365¼ equal parts. It should be noted that the spaces are the *projections* of equal parts; and that one-half of the equator which is projected in an ellipse is above, and the other half is below the ecliptic. The length of a mean time day is the interval of time during which the earth rotates on its axis (i. e., a sidereal day) increased by the interval represented by one space on the equator which is nearly four minutes $\left(=\frac{24 \text{ hrs.}}{365.25}\right)$. This increment multiplied by 365.25 accounts for the additional rotation, making in the year one more than the number of days indicate.

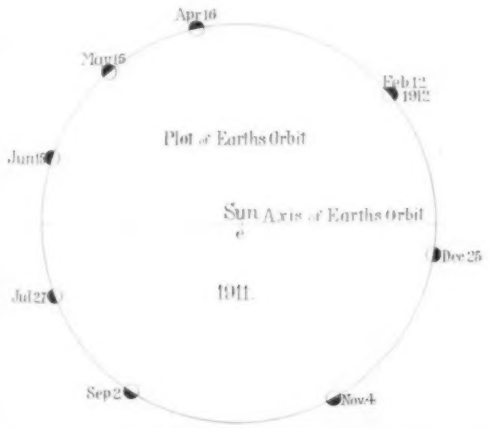


Diagram of the Earth's Orbit, Showing Positions of Maximum and No Variation of Mean Time From True Solar Time.

It would be impracticable and unnecessary to design a clock which would give true solar time; but the mean time which our clocks register corresponds with a clock which would give true solar time four times a year; i. e., (at Greenwich) on April 16th to 17th; June 14th to 15th; September 1st to 2nd, and December 25th to 26th, 1911. In the plot of the earth's orbit the position of the earth is shown at these dates, and also at those of maximal variations between the mean and true solar times. In the projection of the earth the full lines show the positions of the meridian at the dates when the clocks would register the same time; and the alternate lines their positions of maximal variations. At noon on April 16th the clocks would differ by about one second, and would register the same time a little later in the day. On May 15th, after an interval of twenty-nine days, the clocks would differ by 3.82 minutes which should be *subtracted* from apparent time. On June 14th to 15th, thirty-one days later, the clocks would give the same time, and would differ by about one second at noon on the 15th; on July 27th by 6.33 minutes, which should be *added* to apparent time. On September 1st to 2nd the clocks would be together, differing at noon on the 2nd by nearly five seconds; and again on December 25th to 26th, differing at noon on the 25th by nearly thirteen seconds. The greatest variations are on November 4th, 1911, and February 12th, 1912. At the former date, 16.34 minutes should be *subtracted* from apparent time; at the latter date, 14.43 minutes should be *added* to apparent time. The variations between the clocks are shown by intervals on the equator and are indicated by arrow heads. The clocks would be together on April 16th, and 60, 139, and 253 days later; and their maximal variations would occur 29, 102, 202, and 302 days after this date. The arrow A shows the direction in which the earth rotates; and the position of the meridian at apparent noon at each date is determined from the position of the earth shown in the plot of its orbit.

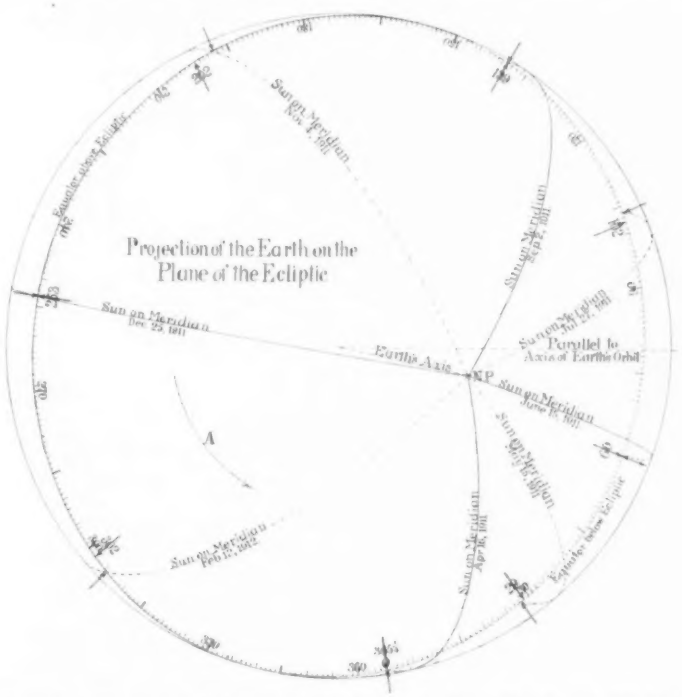

Projection of the Earth on the Plane of the Ecliptic
Sun on Meridian Dec. 25, 1911
Earths Axis
Parallel to Axis of Earths Orbit
Sun on Meridian June 15, 1911
Sun on Meridian Sept. 2, 1911
Sun on Meridian Feb. 12, 1912
Sun on Meridian Apr. 16, 1911
Equator below Ecliptic
A

Diagram Showing the Relation of the Earth to the Ecliptic, and the Dates of Maximum and No Variation of Mean Time From True Solar Time.

Cement and the Colloidal Theory

COLLOIDS in cement were discussed frequently by the late Wilhelm Michaelis and his perseverance in talking about the subject, whether or no people were desirous of listening, gave it a measure of unpopularity for a time. Those who care to look up the colloidal theory will find an account of it by Mr. Edward Godfrey in the *Engineering Record* of October 16th, 1909. It is brought up again in connection with the paper by Prof. White on page 45, describing the expansion and contraction of mortar and concrete when wet and dried. This has also been observed in tests at the laboratory of the U. S. Office of Public Road. Some years ago Dr. A. S. Cushman made many experiments to find the cause of the binding power of certain powdered rocks and later that of the plasticity of clay. This was traced to colloids and could be destroyed by high temperature. If the changes of volume of concrete have a similar colloidal cause, baking will probably destroy it, and a ready means of testing the colloidal theory is therefore available.—*Engineering Record.*

Blaringhem on His New Species

IN reply to various criticism, Dr. Louis Blaringhem, the Belgian botanist, who has been doing some remarkable work in the development of new species, pointed out before the French Academy of Sciences at the meeting of June 6th, 1911, that the forms he had obtained in his experiments with corn, tobacco and other plants were both *new* and *stable*. They are new because no one had ever seen or described such plants before they appeared in his laboratory. They are stable because they have been kept under cultivation for several generations and breed true to seed. He does not claim, however, that he has created anything. By the special treatment to which he subjected the experimental plants—consisting chiefly of traumatic disturbances at critical points in their development—he was able to induce the appearance of the new forms. These new forms he believes to be parts of the inherent potentialities of the parent plants, and likely to arise eventually without any artificial stimulation such as he supplied. All that he did was simply to accelerate the process of evolution.

Transporting Live Fish

A SPECIAL car for transporting live fish has been built for a firm of fish merchants in Saxony. The water in the tank of the car is kept aerated by means of a motor. With this the fish are kept alive on long routes.

The Question of the Combination Projectile

The Ideal of Field Artillery

By Lieut.-Col. Hubner

EFFORTS are constantly being made to simplify field artillery *materiel*. No small amount of study is being devoted to projectiles; for the enormous ammunition consumption of modern guns makes supply more and more difficult.

General Wille, in his "Field Gun of the Future," very aptly termed the combination projectile "the ideal of the field artillery;" but when he added that "unfortunately, there seems to be no present prospect of attaining this ideal," he failed to foresee the great advance that has been made in recent years by our private factories, which would, indeed, probably not have been made if the manufacture of ordnance had remained a monopoly in the hands of one firm.

When the Rheinische Metallwaaren und Maschinenfabrik began to compete successfully with the Krupps, even General Wille admitted, in his pamphlet on the Ehrhardt gun, that this company seemed to have hit upon the principle that would solve the problem of the combination projectile. The Ehrhardt high explosive shrapnel was certainly the first such projectile to be in any degree successful. From an article published in the *Kriegstechnische Zeitschrift* in 1905, on "Shrapnel and Protective Shields," it appears that the Rheinische Metallwaaren und Maschinenfabrik, of Düsseldorf, had begun serious experiments with high explosive shrapnel as early as 1903. As to the result of these experiments, the anonymous writer concludes that "the Ehrhardt van Essen high explosive shrapnel fulfills all the requirements of a combination shell and shrapnel, for use against shields."

Meanwhile the Krupps had been experimenting with a "shrapnel-shell;" and, as the Vienna *Armeeblatt* for Sept. 29th, 1910, rightly remarks, they stood by this type until two years ago. The *Armeeblatt* describes this projectile as follows:

"The shell part is in rear of the shrapnel part, and contains a percussion fuze, so arranged as not to be accessible from without. In time fire the shell explodes just after the ejection of the shrapnel bullets, so that the axes of the two cones of dispersion do not coincide. Hence both parts, shell and shrapnel, can not be effective. Besides this, the shrapnel-shell necessarily contains a relatively small number of bullets; and the effect of the fragments of the case is not sufficient to make up for this disadvantage. For percussion fire the efficiency of the projectile is diminished by the position of the high explosive charge, at the rear end of the case; upon detonation, the effect of the forward part of the case is largely lost.

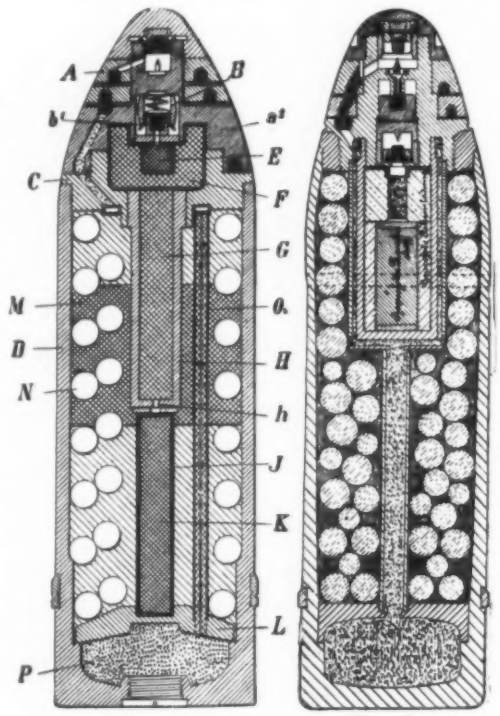


Fig. 1 Krupp's Shell-Shrapnel.

Fig. 2 Ehrhardt Shrapnel II.

"According to a report published in 1906 in the *Zeitschrift für das gesamte Schiess-und Sprengstoffswesen*, experiments showed that the shrapnel shell was then inferior to the high explosive shrapnel against guns, earthworks, masonry, etc. Since that time no considerable progress seems to have been made with this projectile; for the Krupps have recently given it up, and begun to make a combination projectile on the same principle as the Ehrhardt."

General Wille, in his recent pamphlet on combination projectiles, somewhat reluctantly admits the defects of the shrapnel shell. There can be no question that the Rheinische Metallwaaren und Maschinenfabrik brought out the first practical combination projectile, and had only to work out the original principle in improved designs; while the first attempts of the Krupps to follow this lead failed utterly, and they were compelled to make a new start. The new Krupp shell-shrapnel is the result; a projectile described by a foreign paper as being remarkably similar to the Ehrhardt high explosive shrapnel.

Fig. 1* shows the construction of this shell-shrapnel. The shell part is attached at the forward end of the case *D;* it consists of two separate parts, *a'* and *C*, the latter serving to connect *a'* with *D*, and also to carry the heavy tube *H*. The primer composition *b'* of the percussion fuze is placed in *a';* the fuze magazine *E* is surrounded by the front charge *F* of high explosive. The tube *H*, which is screwed into *C*, extends back about half the length of the case, has a vent *L* in its rear end, and contains the second high explosive charge *G*. A third charge *K* is inclosed in the thin-walled tube *J*, which is seated in the diaphragm L. Thus there are three separate charges of high explosive, *F*, *G* and *K*, lying in the axis of the projectile. There is still a fourth, *M*, which serves as a matrix for the bullets *N*.

The shrapnel bursting charge *P* is in the base chamber, which is closed in front by the diaphragm *L*, and is accessible from the rear by a hole closed by a screw. According to General Wille's "Combination Projectiles," this charge consists of smokeless powder or some other similar explosive, capable of either explosion or detonation according to the strength of the primer blow. It is connected with the time fuse *A* by a tube *Q*, placed eccentrically in the projectile, whose bore is so small that, according to General Wille, the flame from the fuse is throttled down so as to cause only an explosion, not a detonation. He states that by practical experiment it is an easy matter to determine the proper size of the tube, and to insure getting the desired grade of explosion.

This projectile contains no smoke producer.

The awkwardness of design of the projectile at once strikes any unprejudiced student; and it is so complicated that one can hardly admit that it satisfies the first requirements of a field artillery projectile. Its manufacture requires highly skilled workmen and plenty of time.

One of its greatest faults is the eccentric position of the tube *Q*. Not to mention the strain upon this tube due to centrifugal force, any projectile whose center of gravity does not lie in its axis of rotation must tend in flight to depart from the plane of fire. It is, of course, extremely difficult in any projectile to make the center of gravity perfectly true; but it is important to avoid any peculiarity of design which necessarily removes it from the axis.

So far as known, the Krupp projectile has been nowhere adopted; and it may be doubted whether it will ever become a dangerous competitor of the latest Ehrhardt high explosive shrapnel.

When General Wille wrote his pamphlet on combination projectiles he was undoubtedly not familiar with the most recent Ehrhardt-van Essen models. It is, nevertheless, very strange that he did not comment on the remarkable similarity between this high explosive shrapnel and the Krupp shell-shrapnel. The reply of the Rheinische Metallwaaren und Maschinenfabrik to his pamphlet says, very pertinently: "The shrapnel-shell having failed, the Krupps were compelled to invert their whole design; putting the upper part of their old projectile on the bottom of the new one, they made the corresponding change in name, and so evolved the shell-shrapnel. The similarity of this latter projectile to the high explosive shrapnel becomes even more striking when it is noted that in time fire the rear charge of high explosive does not act at all. But the shell-shrapnel by no means possesses the merit of the high explosive shrapnel; the Ehrhardt patents prevent."

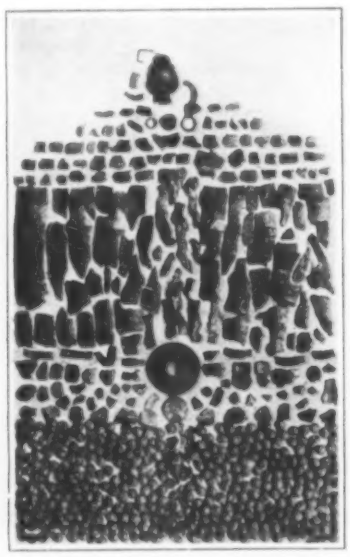


Fig. 5.—Fragmentation of Krupp 3.7 Caliber Shell-Shrapnel (Gen. Wille). 135 fragments under 5 grammes, besides bullets.

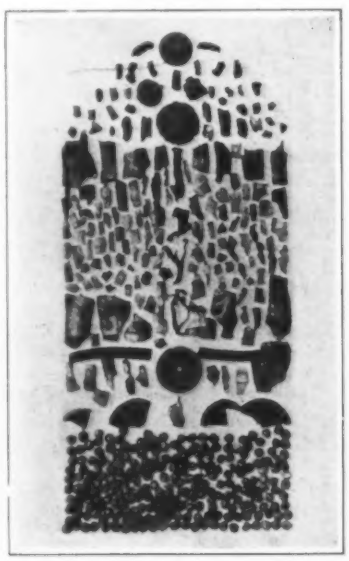


Fig. 6.—Fragmentation of 7.5 centimeter Ehrhardt-van Essen Shrapnel. 170 Fragments over 5 Grammes, 22 under; Head Alone, 61 over 5, Grammes 29 under.

Fig. 7.—The Destructive Effect of a High-Explosive Ehrhardt-van Essen Projectile on a Wall of Masonry.

* Figs. 1, 2, 3 and 5 are taken by permission from General Wille's "Combination Projectiles" (R. Esmschmidt, Berlin); Figs. 4 and 6 and plates I and II, from a pamphlet published by the Rheinische Metallwaaren und Maschinenfabrik, entitled "The Ehrhardt High Explosive Shrapnel and the Krupp Shell-Shrapnel; a Reply to General Wille's 'Combination Projectile.'"

As for the shell part of the Krupp projectile, not only is its connection with the case essentially the same as in Ehrhardt's Model III (Fig. 3), but the high explosive charge is similarly located. But in the Krupp projectile this shell part has the defect of being itself made up of two distinct parts. Besides this, the shell part, as in the earlier Ehrhardt models, is screwed into the case, and its fuse is permanently fixed in its seat. Still another weak point is the Krupp mechanical safety device; the fuse is fully armed at the instant of discharge, and, with low muzzle velocity, projectiles

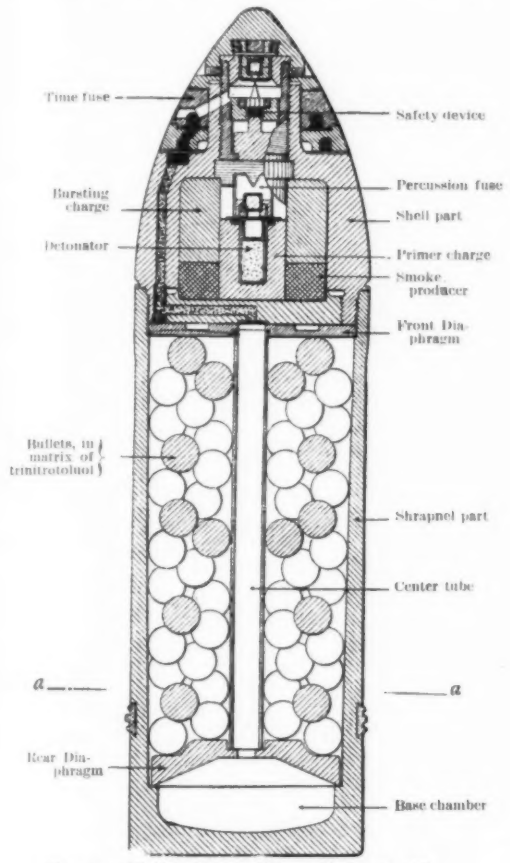


Fig. 3.—Ehrhardt-van Essen Shrapnel III.

meeting an obstacle close in front of the battery might be dangerous to it.

The heavy tube screwed into the shell part, and forming a part of it, extends, as above noted, about halfway to the base of the projectile; a second tube extends from there to the base. The explosive charge is not continuous throughout, and it seems doubtful whether a complete detonation is assured.

In the latest Ehrhardt model (Fig. 4), the fuse is not permanently seated in the head, but may be unscrewed and kept separately; and the detonator may be removed for inspection or renewal without dismounting the whole fuse. The strong steel envelope containing the high explosive charge is not screwed into the case, but pressed in; this insures its being blown off at the point of burst, and continuing on the original trajectory to the point of fall. The tube connecting the fuse with the base charge is central, and not eccentric, as in the Krupp projectile. All models contain a smoke producer. And finally, the Ehrhardt safety device is superior to the Krupp.

In the latest Ehrhardt-van Essen models the upper covering diaphragm of the shrapnel part is omitted, the design of the shell part being such as to render it unnecessary. Trinitrotoluol is used as a matrix; and the modification in the shell part in the fuse have permitted an increase in the number of bullets.

The manufacture of the Ehrhardt projectile is very

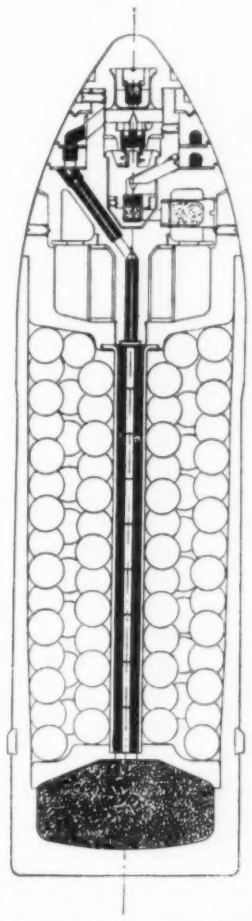


Fig. 4.—Ehrhardt-van Essen Shrapnel IV.

simple. The cases are forged, and finished on the lathe. There are no screw threads except the one for securing the fuse; the Krupp shell-shrapnel has no less then four.

Assembling is also easy. All parts are easy of access, and there are no delicate processes, such as inserting the eccentric tube in the Krupp projectile.

Figs. 5 and 6 indicate that the fragmentation of the Ehrhardt projectile is the better. In the Krupp, the point is not completely broken up. The case shows several excessively large pieces; how many fragments there are over 5 gramme in weight is not stated for the 3.5 caliber projectile. The 3.7 caliber gives an "average" of 135 fragments, 35 less than the Ehrhardt. What this "average" means is not clear, since only a single projectile is considered, and that probably the one that showed the best fragmentation.

The only tests of the shell-shrapnel have been on the Krupp proving ground at Tangelhütte. Of the Ehrhardt projectile there have been six tests at Unterlüss before foreign commissions, and nine others abroad, publicly made before responsible boards of officers. For lack of space, the result can not be discussed here; they are analysed in the "Reply" to General Wille, which well repays study. Figs. 7, 8 and 9 illustrate the effects of the Ehrhardt-van Essen projectile.

Enough has been said to demonstrate not only that the Rheinische Metallwaaren und Maschinenfabrik was the pioneer in developing the combination field artillery projectile, but also that the efforts of the Krupps to solve the problem along different lines were unsuccessful, and had to be given up. Close study of details of construction can not fail to show the astonishing similarity between the latest Krupp shell-shrapnel and the earlier Ehrhardt designs.

The Ehrhardt-van Essen high explosive shrapnel has attained the "ideal" spoken of by General Wille in 1891, in his book, "The Field Gun of the Future."—Condensed for the SCIENTIFIC AMERICAN SUPPLEMENT from *Kriegstechnische Zeitschrift*.

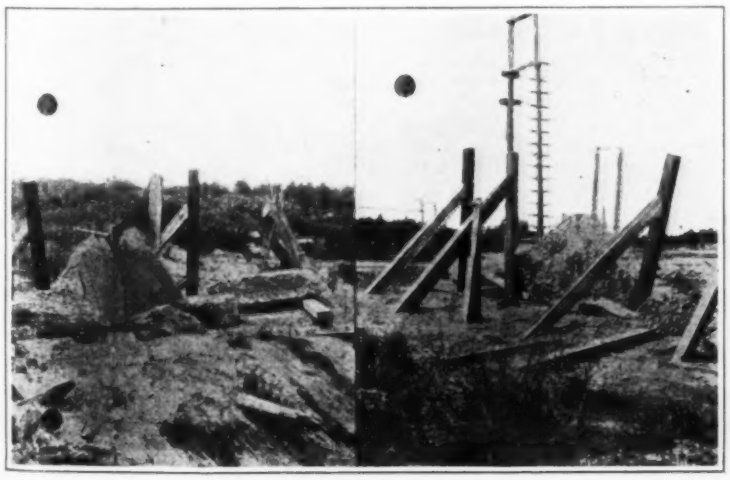


Fig. 8.—Effect of a High-Explosive Shrapnel on a Cement Wall 33 Centimeters Thick; range 200 Meters. Front and Side Views.

Fig. 9.—Effect of the Head of a High-Explosive Shrapnel at 3,000 Meters. Seven Men Disabled or Killed. Forty-six Hits in All.

Rules Governing the Competition for the $15,000 Flying Machine Prize Offered by Mr. Edwin Gould

1. A prize of $15,000 has been offered by Mr. Edwin Gould for the most perfect and practicable heavier-than-air flying machine, designed and demonstrated in this country, and equipped with two or more complete power plants (separate motors and propellers), so connected that any power plant may be operated independently, or that they may be used together.

CONDITIONS OF ENTRY.

2. Competitors for the prize must file with the Contest Committee complete drawings and specifications of their machines, in which the arrangement of the engines and propellers is clearly shown, with the mechanism for throwing into or out of gear one or all of the engines and propellers. Such entry should be addressed to the Contest Committee of the GOULD-SCIENTIFIC AMERICAN Prize, 361 Broadway, New York city. Each contestant, in formally entering his machine, must specify its type (monoplane, biplane, helicopter, etc.), give its principal dimensions, the number and sizes of its motors and propellers, its horse-power, fuel-carrying capacity, and the nature of its steering and controlling devices.

3. Entries must be received at the office of the SCIENTIFIC AMERICAN on or before June 1st, 1912. Contests will take place July 4th, 1912, and following days. At least two machines must be entered in the contest or the prize will not be awarded.

CONTEST COMMITTEE.

4. The committee will consist of a representative of the SCIENTIFIC AMERICAN, a representative of the Aero Club of America, and the representative of some technical institute. This committee shall pass upon the practicability and efficiency of all the machines entered in competition, and they shall also act as judges in determining which machine has made the best flights and complied with the tests upon which the winning of the prize is conditional. The decision of this committee shall be final.

CONDITIONS OF THE TEST.

5. Before making a flight each contestant or his agent must prove to the satisfaction of the Contest Committee that he is able to drive each engine and propeller independently of the other or others, and that he is able to couple up all engines and propellers and drive them in unison. No machine will be allowed to compete unless it can fulfill these require-

ments to the satisfaction of the Contest Committee. The prize shall not be awarded unless the competitor can demonstrate that he is able to drive his machine in a continuous flight, over a designated course; and for a period of at least one hour he must run with one of his power plants disconnected; also he must drive his engines during said flight alternately and together. Recording tachometers attached to the motors can probably be used to prove such performance.

In the judging of the performances of the various machines, the questions of stability, ease of control and safety will also be taken into consideration by the judges. The machine best fulfilling these conditions shall be awarded the prize.

6. All heavier-than-air machines of any type whatever—aeroplanes, helicopters, ornithopters, etc.—shall be entitled to compete for the prize, but all machines carrying a balloon or gas-containing envelope for purposes of support are excluded from the competition.

7. The flights will be made under reasonable conditions of weather. The judges will, at their discretion, order the flights to begin at any time they may see fit, provided they consider the weather conditions sufficiently favorable.

8. No entry fee will be charged, but the contestant must pay for the transportation of his machine to and from the field of trial.

9. The place of holding the trial shall be determined by the Contest Committee, and the location of such place of trial shall be announced on or about June 1st, 1912.

10. Mr. Edwin Gould, Munn & Co., Inc., publishers of the SCIENTIFIC AMERICAN, and the judges who will be selected to pass upon machines, are not to be held responsible for any accident which may occur in storing or demonstrating the machines on the testing ground.

Photography an Aid to Astronomy*

Where the Photographic Plate Excels the Eye

To APPRECIATE the use of photography, try to imagine, if you can, a state of existence deprived of the sense of sight, not only in the individual, but throughout the human race. The phenomenon of light could doubtless still exist, and even be capable of exerting certain physiological action, but this phenomenon is one with which we are primarily cognizant through the direct physiological action on the optical nerves, and without which the intercourse of the individual with the external world is, perhaps, limited by the further senses of "sound," "touch," "smell," and "taste." All these senses, even including the first, are brought into operation only by closely adjacent surroundings, whereas the additional sense of sight, apart from its use as a means of communication between individuals, is the sole remaining sense by which we can obtain information regarding unexplored and otherwise inaccessible regions. I venture to doubt whether, under such conditions, the human intellect would have risen to such primary conceptions as that of a "point" and a "line," let alone a "straight line," and whether even the most primitive of the sciences—that of geometry—could have originated, though, perhaps, a sense of geometrical form might have been developed through the touch. Be that as it may, however, it is perhaps not too much to say that our knowledge of the extra-terrestrial universe has at least until recently been derived solely through the medium of these æthereal vibrations which we call light, to which our eyes respond, thus communicating with the brain, and, though this physical phenomenon might conceivably have existed apart from the existence of human or other eyes, its existence could scarcely have been recognized, and the science of astronomy, which deals primarily with extra-terrestrial phenomena, could hardly have been. Thus it is that the development of this science has been largely concurrent with the development of those instruments by which the optical efficiency of the eye has been increased. The earliest observations were made with the unaided eye, the results of which have come down to us, being duly recorded either in the form of descriptions or drawings, or even, in some cases, by more or less exact measurements. The introduction of the telescope not only immediately opened up fields of vision previously inaccessible, but facilitated in a very marked degree the precision with which measurements could be made, and for about three centuries the telescope has been used as a direct aid to the visual organ. It is improbable that this method of observation will never be superseded, but there is to-day a growing tendency to replace the human eye at the end of the telescope by the photographic camera.

The advantages of the method are two-fold: (1) Objects which are too faint to be seen with the eye may yet be photographed by a sufficient extension of the time of exposure, and our powers of penetrating the confines of space is thereby increased; (2) the photographs themselves form a permanent record of what is seen more trustworthy than can be obtained from any drawing or description executed at the hands of man. The early application of the art of photography to astronomy related to the subject from its descriptive aspect rather than to those branches of the science which depend on exact measurement. With the aid of reflecting telescopes of large aperture, it was found possible to delineate with certainty the forms of vast nebulæ, so as to establish with great nicety the extension of their convolutions into regions where to the eye alone their traces were quite invisible, even with the aid of powerful telescopes. But, fascinating as these photographs are in aspect, valuable as they are as early records, and suggestive as they are with regard to the cosmical significance of the objects photographed, it can scarcely be maintained that they have so far been prolific in scientific results. Such phenomena as the wonderful spiral forms assumed by many of the nebulæ, though proved to be far more common than was previously realized, remain as obscure as ever in their origin. In making this statement, I do not wish to underrate the work of the earlier pioneers in astronomical photography. They have developed methods which we continue to use, and have but little to improve on, and they are not to be blamed if the full value of their work has not been attained in their own generation. Visual work had already been carried so far that the extended vision afforded by photography could hardly have been expected to lead instantaneously to any new and startling phenomenon which should revolutionize existing ideas of the extra-terrestrial universe. It is only as time lapses, and we are able to study the changes which are taking place since these photographs were secured —changes which, as a rule, take place so exceedingly slowly as not yet to be fully established—that the full advantage of the new method over the old will be realized.

The earliest attempts at the photography of celestial objects seems to date back so far as the year 1840, when photographs of the moon were obtained by daguerreotype processes, but beyond its use for pictorial representation, to which, perhaps, I might add the daily photographic record of the sun's surface, instituted at Greenwich in 1873, the unsuccessful attempts by Pritchard at the instigation of Warren de la Rue to utilize it for the determination of the constant of nutation—for a long time it seems to have been regarded with suspicion for purposes requiring the use of exact measurements. While photography might supplant the astronomical draughtsman, its limitations were in other respects similar to those affecting the draughtsman's art and skill. The latter aspects of its uses are those which I propose chiefly to deal with to-night, not that I wish to underrate the importance of other applications, but that I prefer rather to confine myself to those branches with which I have myself been more directly concerned. The year 1882 saw the first introduction of astronomical photography into the Cape Observatory. No special appliances for the purposes were at the time included in its equipment, but the unexpected appearance of the great comet of that year demanded that an effort should be made to secure a representation of this comet by photographic methods, which had been vigorously developed elsewhere for such purposes. Accordingly, the services of a local photographer were secured, and in order to obtain a sufficiently long exposure to bring out the faint detail of the comet's tail, his camera was attached to one of the equatorial telescopes of the observatory, so that it might partake of the motion imparted to the telescope, and thus be kept pointed on the comet for a prolonged interval. Valuable photographs showing much detail of the structure of the comet were obtained, but the feature to which particular attention was directed was the large number of stars, some of them extremely faint, which, besides the comet, were all duly recorded on the plate. Moreover, the sharpness of the photographic images suggested that they would permit of very accurate measurement, and that, if only similar definition could be obtained in photographs on a more open scale, it might be possible to replace many of the laborious methods of measurement hitherto conducted by direct visual observations on the sky itself by somewhat similar methods applied to the photographs.

There existed at the time no comprehensive survey of the southern skies. A complete catalogue of the stars in the northern heavens, known as the Bonn "Durchmusterung," giving the positions and magnitude of all stars down to the ninth visual magnitude, with a precision at least accurate enough to insure their identification in the sky, had been formed by Argelander, and extended to a portion of the Southern Hemisphere by his successor, Schönfeld, but the remainder of the heavens from 23 degrees S. declination to the South Pole, was still comparatively unknown. The photographs I have referred to suggested a means by which this lacuna might be filled, and no sooner was this idea conceived by Sir David Gill than steps were taken to put it into active execution. Partly at his own personal expense, and partly by means of assistance from the Government Grant Fund, administered by the Royal Society of London, the necessary equipment and the services of a photographer were secured, and between the years 1885 to 1889 a complete series of photographs of the region extending from 18 degrees S. declination to the South Pole was obtained. In order, however, that these photographs might be of value to science, it was necessary that the facts duly recorded on them should be minutely examined and rendered accessible to astronomers generally, in the form of a catalogue. As more than 400,000 stars were involved, this in itself was no light task, and might well give rise to the question as to whether the necessary measurements could not be more advantageously made on the sky rather than on the photographic plates by which it was represented. The method which was subsequently adopted for the formation of this catalogue forms sufficient answer to this question. The resources of the observatory were unequal to so large an undertaking, at least without the cessation of a large proportion of its normal work, and it appeared probable that the photographs would have to remain in the record room of the observatory, valuable for consultation regarding specific points which might arise, but that their complete discussion would have to be relegated to a perhaps remote future. The difficulty was at this juncture met by a generous offer received from Prof. Kapteyn, of Gröningen. Prof. Kapteyn was himself an enthusiastic astronomer, eagerly desirous of devoting himself to work of this character, with full appreciation of its value, but unfortunately unprovided with an observatory equipment. He foresaw that, with the aid of a comparatively small laboratory equipment, much of the work of a character which had hitherto been performed by reference to the sky could be effectively and rapidly carried out through the medium of photographic representations thereof. The series of photographs secured at the Cape formed a promising field for research, and he voluntarily undertook the laborious task of the measurement of these plates and the preparation of a catalogue, which has since been issued among the publications of the Cape Observatory, and to-day is in constant use by astronomers concerned with the Southern Hemisphere. Besides many incidental results of high interest, the catalogue forms the basis for statistical investigations of stellar distribution, etc.

The success of the project, even in the early stages of its execution, pointed to the possibilities of a still more extended use of the photographic methods, and gave a direct stimulus to the study of the details by which its efficiency could be increased. The surveys of Argelander and Schönfeld, completed by the "Cape Photographic Durchmusterung" (as the above catalogue is entitled), and independently by a visual "Durchmusterung" emanating from the observatory at Cordoba, under the direction of Dr. Thome, could but be regarded as preliminary pioneer surveys; but, stupendous as the task seemed, the possibility was recognized by Sir David Gill of utilizing the photographic method for the production of a complete map of the heavens, which should be on a sufficiently large scale and sufficiently precise in its detail to meet all the requirements of modern astronomy of precision. He succeeded in securing the interest of astronomers generally, and in particular of Admiral Mouchez, the director at that time of the Paris Observatory, at whose instance, with the support of the Paris Academy of Sciences, an international conference of astronomers was invited to meet in Paris in 1887 to discuss the possibility and desirability of carrying out this extended project. While the plan in outline met with universal acceptance, much useful discussion

* Presidential address delivered before the Royal Society of South Africa on April 19th, by Mr. S. S. Hough, F.R.S.

took place at this and at subsequent conferences as to the details of its execution, such as the type of instrument to be employed, the scale of the photographs, the duration of exposure which would serve to bring out what should be considered essential detail, etc. The outcome was that an agreement was arrived at by which the execution of the work was partitioned among eighteen co-operating observatories, who among them undertook to secure photographs of the whole sky with instruments of similar dimensions and design, and, so far as possible, similar conditions of exposure. Two series of photographs were to be taken, one of long exposure, designed for direct photographic reproduction to form an atlas which would show all stars down to the fourteenth visual magnitude, and a second series, of shorter length of exposure, designed for exact measurement, which would form the basis of a catalogue of precision of all stars to the eleventh magnitude. Minor details were largely left to the discretion of the directors of the co-operating observatories.

It would take too long to describe in detail the progress of this work from its initiation, and I propose, therefore, to confine my attention to the share in it which has been taken by the observatory over which I have the honor to preside, a share which, partly from the origin of the project and partly from the scarcity of suitably situated observatories of a sufficiently permanent character in the southern hemisphere able to offer co-operation, has exceeded that assigned to any other single establishment. The type of instrument agreed upon was the photographic refractor, similar in dimensions to that which has been used by the Brothers Henry in Paris, giving pictures on such a scale that one millimeter on the plate corresponds with a minute of arc on the sky. The plates were to be 160 millimeters square, so as, apart from the marginal edges, to yield an effective field of views of two degrees square. The area covered by each plate will perhaps be better presented to you by the statement that the length of the edge of the plate corresponds, roughly, with four times the apparent diameter of the sun or moon, i. e., four suns and four moons photographed side by side on the same plate would just reach from one edge of the plate to the other. On this scale it would require rather more than 10,000 plates to cover the whole sky. The programme, however, provided not merely for the photographing of each region once, and once only, but that the various regions covered by the separate photographs should overlap in such a way that every star would be contained in two of the regions at least. Thus any doubtful features shown in one plate could be verified by reference to the second plate, which includes the same area. This requirement raised the total number of separate regions to be photographed to 22,054, of which 1,512 were assigned to the Cape Observatory. The construction of the telescope and the provision of suitable housing accommodation was sanctioned in 1888, and the telescope arrived at the Cape in 1890. About two years were spent in its erection, adjustment, and testing, the delay being largely due to the necessity for returning the object-glass for necessary alterations and the remodelling of the breech-piece, which could not be effected locally. From July, 1902, onward, the work of taking the photographs was steadily proceeded with until its completion in 1910. At the present time we have stored at the Cape three almost complete series of photographs of the 1,512 regions, besides many duplicates and triplicates, which, though not attaining the desired standard of perfection, are still available for reference with regard to many issues that arise. Of these plates, one series of long exposure is destined for direct photographic reproduction; the other two series of shorter duration of exposure is destined for direct photographic reproduction; the other two series of shorter duration of exposue for measurement for the purposes of the catalogue. On account of the comparatively insignificant amount of work involved in taking these catalogue plates as compared with the more laborious work of measurement, after its original completion in 1896 it was decided to repeat the whole series of catalogue plates, so as to bring the dates of the photographs nearer to the epoch 1900, and thereby more fully attain the ideal before the International Conference of leaving for a future generation as exact a record as possible of the appearance of the heavens at the beginning of the twentieth century.

After some early experiments with the view of ascertaining the most economical means by which these plates might be measured with the desired accuracy, the definitive programme of measurement was commenced in 1897, and completed last year. The number of stars measured on a plate varies between 45 and 3,431, the total number of star images which have been measured exceeding a million. To illustrate the precision attained, the discordances in the position of a star, relatively to the stars immediately surrounding it, as derived independently from the measures made on two overlapping plates, but rarely amount to so much as a second of arc, i. e., apparent angular distance between the two edges of a halfpenny at a distance of about three miles from the observer. Now, however exactly the measurable features of each plate may be determined, it will be clear that the information thus derived can be of little value without some external data to enable the identification of the region on the photograph with the corresponding region of the sky from which it is derived. A plan of this room might have been useful to enable you to find your seats to-night in positions corresponding to the numbers on your tickets, but I venture to think a stranger visiting Cape Town for the first time would prefer to have been provided with a map of the town, which would indicate the position of this hall, rather than to have to search the town for a room arranged according to such a plan. So with our photographs, the detailed study of each photograph can be of minor value without some indications enabling us to identify the field shown on the photograph, not only in relation to the surrounding fields, but in relation to the sky as a whole. It is certainly a desideratum that these indications should be not less precise than those involved in the measures themselves. Of course, if each photograph contained some familiar group of stars, such, for instance, as the constellation Orion, the identity of the region could not be easily mistaken; but the scale of which the plates are taken is such that two such familiar stars are rarely to be found within the limits of a single plate, while many plates are devoid of stars to which accurate positions could have been previously assigned.

The necessity has thus arisen of determining with high accuracy the absolute positions as opposed to the relative positions indicated by the plate itself, or at least two stars contained on each plate. The distance between the images of these stars as compared with the corresponding apparent distance on the sky serves to furnish a determination of the scale of the plate, while the direction of the line joining them serves to fix the orientation of the plate, i. e., enables us to turn the plate round in its own plane, so that the true N. and S. line may be placed exactly in a truly horizontal, truly vertical, or, in fact, any other desired direction. With these quantities correctly assigned, either star will be sufficient to correlate the plate exactly with the sky. In practice it is customary to refer to a larger number of stars than two on each plate. Not only are the determination of these necessary "plate constants" strengthened thereby, but in the consistency with which the photographic pictures reproduce the actual distribution of the stars, we have a valuable check on our methods and a test of the faithfulness with which also other features on the sky are represented on the photographs. For the Cape plates, the determination of the "plate constants," i. e., of those elements which serve, as it were, for the co-ordination of the isolated maps contained on each plate with a general map of the whole, has been made to depend on a number of stars of each plate varying, as a rule, between 8 and 12. In all, 8,560 stars, so far as possible evenly distributed over the whole of the zone, were selected as comparison stars. These stars constitute a framework to which the detailed results derived from the photographs may be attached, but the structure of which requires to be independently built up. For such a purpose, photographic methods have not as yet proved available, and recourse was necessary to the older method of visual observing with the meridian circle. From observations made in the years 1897-1900 with the transit circle, an accurate catalogue of these 8,560 stars has now been formed, and has been utilized for the purpose of standardizing each of our plates. The heavy arithmetical work involved in applying to each of our original measures more than two millions in number, the derived correction to refer the whole to a common standard is now rapidly proceeding, and at the present time is about half completed.

I have above referred to the catalogue of 8,560 comparison stars as framework for the support of the more extensive photographic catalogue. Such a famework, at least on the basis on which the one was constructed, is not entirely self-supporting, and it thus behooves us to carefully consider its foundations and to insure that they possess the necessary solidarity. Not the least of the important questions brought up for discussion at the last meeting of the International Committee charged with the conduct of the photographic work was that of the steps to be taken for this purpose. It was recognized on all sides that even the best existing meridian catalogues were inadequate, and that they would have to be supplemented by extensive additional observations. The main object of the discussion was to secure the most extensive co-operation from observatories provided with suitable meridian equipment, and to classify the work in various grades of accuracy, so that each establishment might devote itself primarily to that branch for which its equipment was best adapted, at the same time keeping in view the co-ordination of its work with the larger scheme. The resolutions adopted have since been favorably received by meridian observers, and we may look in the future to a systematic organization of meridian astronomy throughout the world, the results of which, apart from the mere economic aspect, cannot fail to be of the highest importance to science. It may well be asked, What is the use of such a chart as you have been describing? or, Will it repay the enormous cost involved in compiling it? As regards its use, I endeavored to indicate in my address last year some of the problems which awaited solution, and which serve to inspire the astronomer in conduct of the lengthy routine operations involved. These motives are, perhaps, for the most part scientific and intellectual, rather than utilitarian, and it is possible, even probable, that to many of the questions arising answers which will afford complete satisfaction will not be forthcoming, at least for a generation or two to come. I think I am sufficiently voicing the view of those who took part in the original discussions at Paris when I state that they, as a body, attached greater importance to the complete and thorough systematic record of the phenomena prevailing during their own generation than to the immediate interpretation of these phenomena. It was felt to be a scientific duty, incumbent on them, to provide, so far as lay within their means and capacity, data which should be beyond reproach. By this means they were preparing the ground and planting the seed, which they hoped would yield a rich crop of scientific results, even though it should remain for their children's children to reap the harvest.

Much has already been attained. The ghosts which beset the use of photography in relation to the science of exact measurement have in a large measure been laid, and photographic methods have now been successfully used for some of the most delicate measurements ever attempted even by direct visual operation. I have in mind such questions as the determination of the distance of annual parallaxes of the fixed stars, and of the parallax of the sun, in connection with which, under the auspices of the Paris conference, an extensive photographic campaign, combined with visual methods, was undertaken on the occasion of the near approach of the planet Eros in the years 1900-1901. The discovery of the latter planet was itself a product of photography, while by similar means the number of known minor planets has within the last few years increased by leaps and bounds, until at the present day they are nearly 700 in number. Photography has also been prolific in the discovery of variable stars and new stars, and the tracing of their light changes. All these purposes will be greatly facilitated by the existence of a trustworthy chart or catalogue containing more especially the fainter stars about which our exact knowledge hitherto has been almost non-existant. Time must elapse before we may expect to be able to evaluate with any certainty the slow changes of position due to the proper motion, at least, in relation to the previously uncatalogued faint stars; but this is to-day one of the greatest desiderata for the advancement of our knowledge of the universe, and is one of the purposes for which the photographic catalogue was primarily intended. By photographic methods and by co-operative effort throughout the world alone has it been possible to collect evidence on a sufficiently wholesale scale, so that already we are beginning to feel the solution of some of the most profound problems relating to the universe almost within our grasp.

Fish Life

AT the recent Conversazione of the Royal Society, Dr. Francis exhibited some photographs of fish life as seen from below the surface of the water, and micro-photographs of the growth of larval fish (plaice) taken from life.

The photographs were taken in a pond especially constructed for the purpose. In one wall of the pond was a large open space, which communicated with an observation chamber, and between this chamber and the water in the pond was a sheet of plate glass. Concealed in the chamber, the observer could watch the fish as they appeared to one another in the water In consequence of the darkness in the chamber and the light in the pond, the glass acted as a mirror, and the fish merely saw himself and his surroundings reflected, while the observer could plainly see into the pond. It was thus possible to observe a timid fish without disturbing him. In addition an instantaneous photograph could be taken at 1/250 of a second.

Unmagnetizable Steel

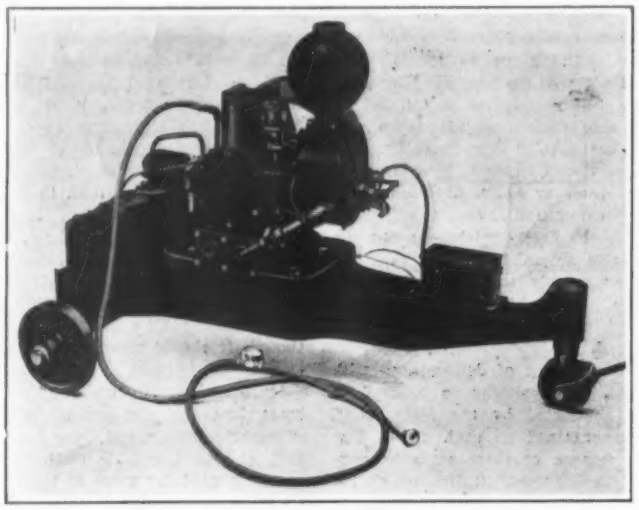
AN unmagnetizable steel alloy is said to contain manganese, 9.8 to 10.3 per cent; titanium, 0.2 to 1.4 per cent. The silicon must not exceed 0.8 per cent; carbon, 0.03 per cent; and phosphorus, 0.015 per cent.

Novel Portable Gasoline Motor-driven Air Compressor

Suitable for Inflating Pneumatic Tires

By Frank C. Perkins

THE accompanying illustration shows a unique portable gasoline motor-driven air compressor. In devising this combination motor and compressor the main object in view was to get a machine that would deliver a large volume of air, give ample pressure and meet the demand for a simple, compact and durable device.



A NOVEL PORTABLE GASOLINE MOTOR-DRIVEN AIR COMPRESSOR

The motor is built on the improved lines developed in modern automobile construction and delivers nearly two horse-power. This enables it to inflate the largest tire made in much less than one minute. The motor is water cooled and is perfectly balanced mechanically. It is nearly noiseless, being comparable in this respect to a sewing machine, and is remarkably free from vibration.

It will be seen from our illustration that the motor is mounted on a solid iron truck made in one piece, and can be rolled around very easily from place to place. The compressor part has no ball or check valves in its construction, both inlet and outlet valves being bevel seated and ground to a perfect fit.

It is stated that there is absolutely no dead space at end of compression strokes, and therefore all air that enters into cylinder on intake stroke is forced into the tire. The air is delivered through a shock absorbing device, and therefore all the air is delivered to the tire in a steady stream. A special feature of this shock absorber is an arrangement which prevents any possible passage of oil into the tire.

This air compressor presents obvious advantages over electrically driven and other forms of apparatus, in that it requires no lead or any other connection, and is thus free to be wheeled around wherever needed. It is always ready for service, and commands twice the pressure required for inflating automobile tires. Two cents worth of gasoline will inflate from twenty to fifty tires, according to size and pressure. The capacity of the apparatus is at least four times as great in volume, and twice as great in pressure, as that of the usual types of electric compressors fed from electric light mains. It can of course, if desired, be used for operating various minor machinery, where light and intermittent power is required.

Radiometer Motion Stopped by a Very High Vacuum

AT the recent Conversazione of the Royal Society, Sir James Dewar exhibited a radiometer motion stopped by a very high vacuum.

A radiometer placed in a concentrated beam of the electric arc is stopped by a charcoal liquid air vacuum, and started again by mercury vapor given off by liquid mercury between the ordinary temperature and —25 deg. C., or at a limiting pressure of about one fifty-millionth of an atmosphere. Activity is again arrested on freezing out the mercury vapor by liquid air.

Mirrors were formed by mercury distilling at the ordinary temperature. This is an illustration of the viscosity of the vapor of mercury at low pressures.

Magnets for Handling Cargo

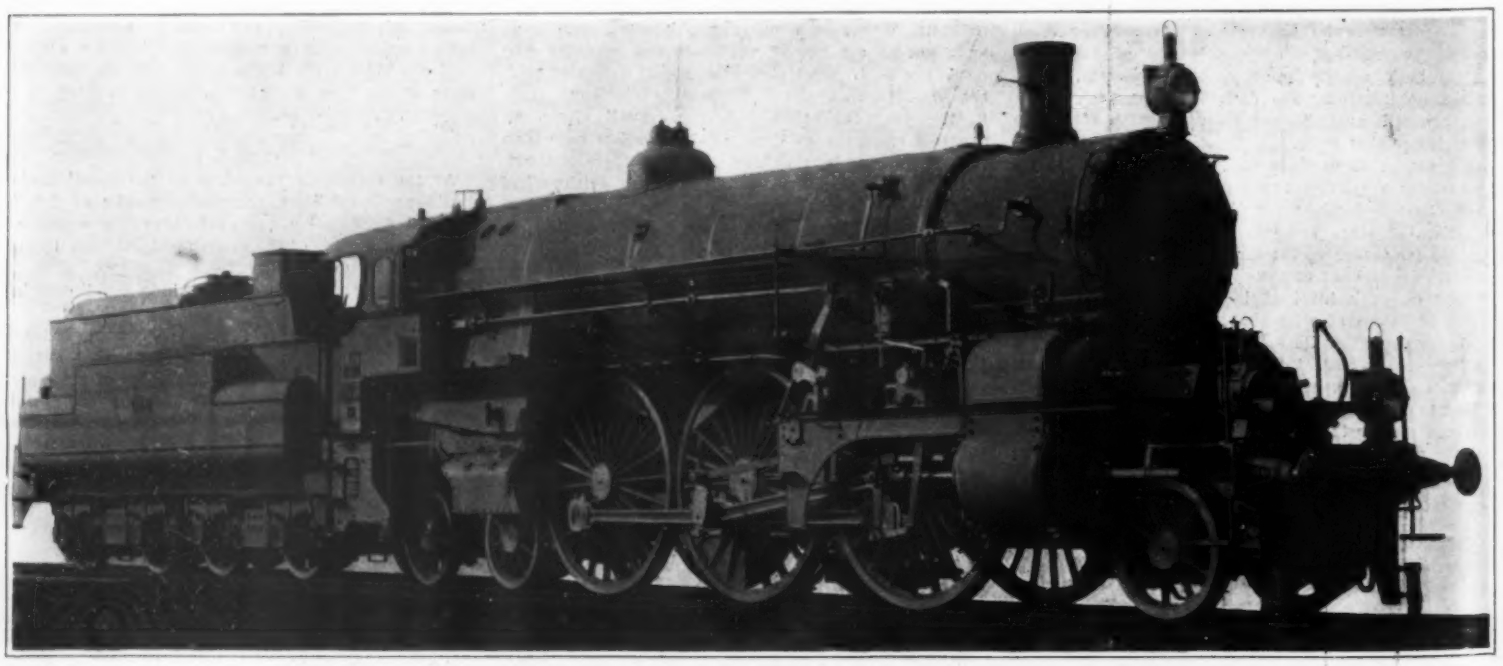
WE hear that two 62-ton lifting magnets recently unloaded over 4,000,000 pounds of pig iron from a steamship in 10½ hours. The maximum number of lifts made in an hour was 73 and the minimum 45. In all 1,281 lifts were made by the two magnets used, the average lift per magnet being 3,427 pounds. With these lifting magnets only two or three men are needed in the hold of the vessel, and no time is lost in filling buckets.

Four-cylinder Compound German Freight Locomotive

A Fine Example of German Construction

WHILE we have as a nation every reason to feel gratified with the technical excellence and practical soundness of our industrial achievements, it is well every now and again to cast a glance across the border and keep informed of the progress in other lands. The firm J. A. Maffei of Munich, Germany, is doing most excellent work in locomotive construction, an example of which is shown in our accompanying illustration. This shows a general view of a freight engine constructed for the government railroad of Baden, Germany.

The following measurements give an idea of the size and general character of this locomotive: Gage, 56.5 inches; fixed wheel base, 15 feet 9 inches; total wheel base, 24 feet 5 inches; total length, 37 feet 6 inches; breadth, 15 feet 3 inches; weight empty, 76.5 metric tons, with working load 77 metric tons; driving wheels, 53.2 inches diameter; drawbar pull, 25,300 pounds; boiler pressure, 240 pounds per square inch; total heating surface, 2636 square feet. The grate area is 40.3 square feet; diameter of the high pressure cylinder, 15.6 inches; stroke, 25.2 inches; diameter of low pressure cylinder, 25 inches. The tanks hold 4,400 gallons; coal bunkers 15,000 pounds.



Total Length, Including Tender, 53 Feet 2 Inches

NEW FREIGHT LOCOMOTIVE BUILT FOR THE GOVERNMENT RAILWAY AT BADEN, GERMANY

The Animal Machine

The New Respiration Calorimeter of the Berlin Agricultural High School

EVERY full grown human being consumes daily about 200 grams or 7 ounces of carbon, which must be supplied in food. Only 10 grams or 1/3 ounce of this carbon appears in the solid and liquid excretions; the rest is eliminated in gaseous form, as carbon dioxide. The daily food should contain also about 40 grams of hydrogen and 220 grams of oxygen, but a much larger quantity of oxygen, 700 grams, is obtained from the atmosphere by respiration. The gases, oxygen, and carbon dioxide, play the leading role in human and animal metabolism, and the exact study of the interchange of gases is required by the solution of problems of nutrition.

Lavoisier, the discoverer of the process of oxidation in animals indicated methods and apparatus which have been improved by later experiments. Prof. Zuntz describes, in *Die Umschau*, the new respiration chamber, which he has constructed for the Berlin Agricultural High School, which not only is more accurate than other apparatus, but is available for the study of problems beyond the range of its predecessors.

The apparatus hitherto employed is of two kinds. In one form, the mouth and nose are connected directly with devices for measuring the quantity of air inhaled and exhaled. This method is particularly well adapted to the study of the oxidation process during short intervals and of its dependence on work, digestion, fever, etc. For periods of a day or more it is better to confine the person or animal in an air-tight chamber. In the classical investigations of Regnault and Reiset, the carbon dioxide exhaled by the animal was absorbed by caustic potash, and pure oxygen was introduced into the chamber to replace the oxygen consumed. In the newer types of this apparatus air is drawn continuously, by a blower, from the chamber, passed through a vessel containing potash lye, which absorbs the carbon dioxide, and returned to the chamber, while oxygen is admitted continuously to replace the oxygen consumed. This method gives an accurate measurement both of the carbon dioxide produced and of the oxygen consumed, in which respect it is superior to Pettenkofer's method, in which the oxygen is determined indirectly.

Pettenkofer's object was to avoid an obvious defect of Regnault's apparatus, confinement in a close and foul atmosphere, loaded with water vapor and volatile excretions. For this purpose he kept the chamber well ventilated by a current of fresh air, and devised a very delicate analytical method by which the carbon dioxide produced could be determined, to within 1 per cent, from the slight difference in the proportions of carbon dioxide in the incoming and outgoing currents. The quantity of combustible gas excreted, which is small in man but large in herbivora, especially ruminants, can also be determined by burning the outflowing air and measuring the increase in carbon dioxide.

The apparatus described below is so constructed that either Regnault's method (with the above-mentioned defect eliminated) or Pettenkofer's method can be employed, while the muscular work performed can be measured with accuracy.

The most natural form of work, for men or animals, is walking. This is made possible by constructing a tread mill inside the respiration chamber (Fig. 1).

A motor outside the chamber drives this treadmill backward at a speed between 20 and 300 meters (66 and 984 feet) per minute, compelling the animal to move forward with a gait varying from a slow walk to a swift run. The platform can be turned on the axis *W* sufficiently to give the effect of an up grade of 30 degrees or a down grade of 20 degrees.

In experiments on the effect of drawing loads, the platform is moved backward by the animal's feet, as in an ordinary treadmill. The motor, disconnected from the city mains which supply it with current when the animal draws no load, is now driven by the treadmill, generating a current which is absorbed by adjustable resistances, and consequently acting as a brake. The load is represented by a weight, attached to the animal by a rope passing around the pullies *X* and *X*¹, and hanging freely. If the resistance in the dynamo circuit is not properly proportioned to the load the weight rises or sinks and thus makes a contact which sends a positive or negative current through a small auxiliary motor, which inserts or cuts out resistance.

The respiration during short periods of work can be measured by inserting a tube in the animal's windpipe, or covering the man's face with a breathing mask, and connecting the tube or the mask with the pipes *J* and *E*. Fresh air is drawn in through the pipe *J*, which is provided with a valve. The pipe *E* leads to the gas-meter *a* (Fig. 3) where the volume of the exhaled air is measured and a specimen of it is collected for analysis.

When Pettenkofer's method is employed the respiration chamber is disconnected from the gas meter *a* (Fig. 3) and is supplied with air by the gas meter *b* which is driven by an electric motor and acts as a pump. The maximum hourly flow, 72 cubic meters (2,543 cubic feet), is equal to the capacity of the chamber, the air in which can therefore be renewed hourly. This ventilation is sufficient to keep the percentage of carbon dioxide in the air at 1/5 per cent, except during short periods of hard work, when the animal is a full grown steer. The air is drawn out at *Hk* (Fig. 1) and the fresh air enters through the pipe *A*. An analysis of specimens of air from different parts of the chamber showed considerable differences in the percentage of carbon dioxide, electric fans *y* and *y*¹, acting in opposition to the ventilation current, were placed near the floor and ceiling. With this arrangement it suffices to analyze specimens of air taken from the inlet and outlet. The variation in the proportion of carbon dioxide found in different analyses of the same specimen by Petterson's method never exceeds 3/1000 per cent. The combustible gases exhaled by herbivora can be determined by converting them into carbon dioxide and water by means of an incandescent platinum wire.

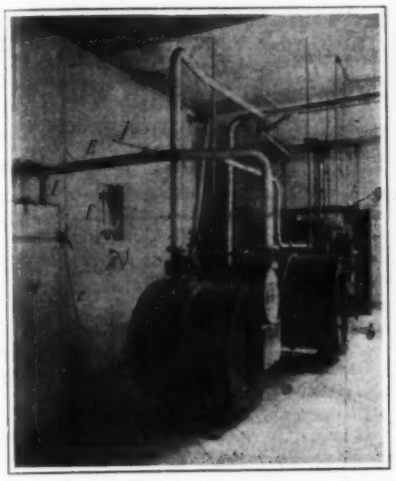


FIG. 3.—GAS METERS.

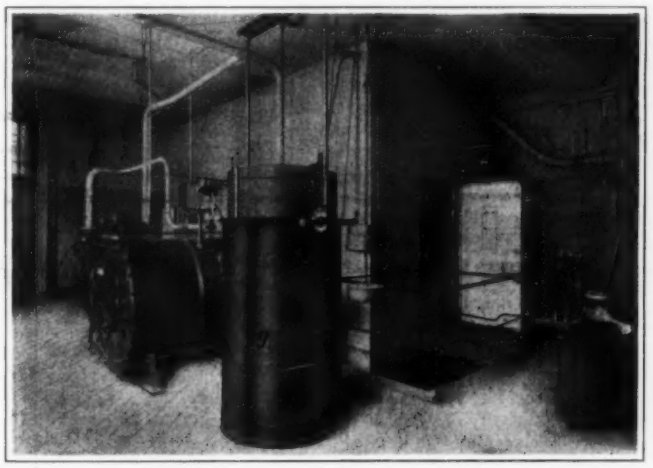


FIG. 4.—EXTERIOR OF RESPIRATION CHAMBER, SHOWING GAS-METERS AND OXYGEN TANK.

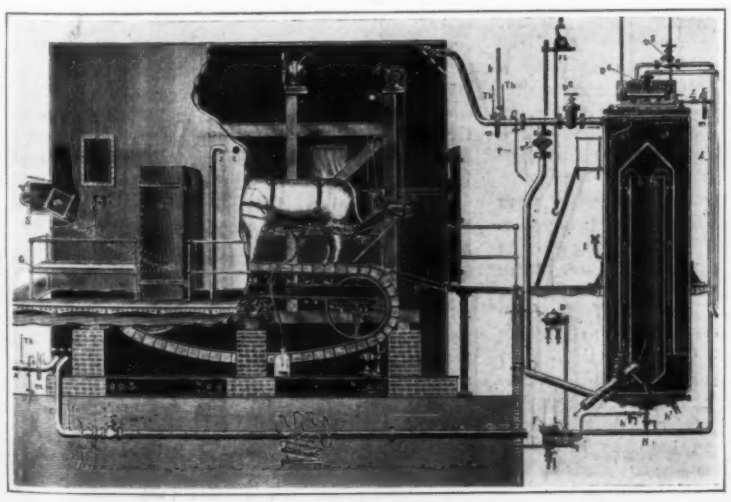


FIG. 1.—THE RESPIRATION CHAMBER AND CONDENSING TOWER.

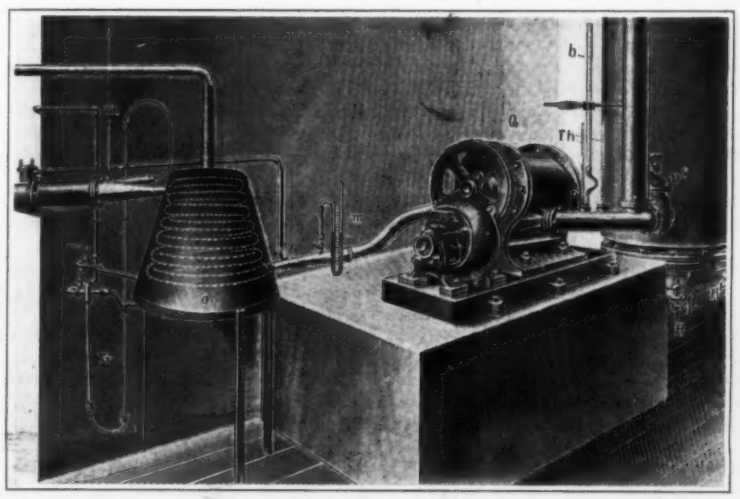


FIG. 2.—AIR HEATER AND PUMP.

THE NEW RESPIRATION CALORIMETER OF THE BERLIN AGRICULTURAL HIGH SCHOOL

When the method of Regnault and Reiset is employed, the confined air is freed from carbon dioxide and water vapor in the condensing tower shown at the right of Fig. 1, which is cooled to 5 deg. F. by pipes in which liquid ammonia is evaporated by the action of a refrigerating machine. At this low temperature the water vapor is completely condensed. At the beginning of the experiment about 20 gallons of potash lye are introduced through the tube *t*. By the pump *L*, driven by the motor *D*, the lye is continuously drawn from the bottom of the tower and forced, through the filter *F* and the pipe *l*, to the top whence it falls in drops upon the refrigerating pipes, the whole of the lye making the complete circuit in 5 minutes. Two concentric cylinders, with their mouths directed respectively upward and downward, cause the air to flow through the tower in the manner indicated by the arrows and to come into intimate contact with the cold pipes, wet with lye. The air flows from the bottom of the tower to the pump *Q* (Fig. 2). The outlet pipe is connected with the inlet pipe at the top by a vertical pipe, through which a portion of the air can be returned to the respiration chamber without passing through the absorption tower, by operating the valve v^2, v^3 and v^4 (Fig. 1).

From the pump *Q* (Fig. 2), which has a capacity of 8 to 16 cubic meters (280 to 560 cubic feet) per minute, the air flows through a coil of pipe *O*, heated by a gas flame which is automatically regulated by the thermostat *Tr*. The pipe *C* (Fig. 1) through which the air returns to the respiration chamber, contains an ether thermometer, which when a certain temperature is exceeded, closes the circuit of an electromagnet which opens a valve in a tube by which part of the air flows directly from the pump to the return pipe *C*, without passing through the heater *O*. In this way the temperature of the air is regulated with great precision. The return pipe *C* is provided also with an anemometer *V*, a cock v^1, a manometer *m* and a vessel *p* for collecting specimens of air for analysis. In its passage from the respiration chamber to the condensing tower the air meets a pair of very sensitive dry and wet bulb thermometers *Th*, *Th*, reading to 1/100 deg. C., and it encounters a similar pair on leaving the condensing tower. The quantity of water vapor in the air, in each case, can be deduced from the readings of the dry and wet bulb thermometers.

In conducting an experiment by Regnault's method the circulation of the air through the apparatus and that of the lye in the condensing tower are first maintained for two hours. Specimens of the air entering and issuing from the respiration chamber are then collected in the tubes *p p* and a specimen of lye in the tube *H*. At the same time the thermometers, the barometer and several water manometers in the respiration chamber are read, as well as thermo-barometer which gives a very accurate indication of the mean temperature in the chamber. All of these readings are repeated and new specimens of air and lye are taken after each period of experiment. The quantity of carbon dioxide in an aliquot part of the lye is determined. The percentage of potassium in the lye, compared with the initial percentage, indicates the degree by which the lye has become diluted during the experiment. From this result, combined with the readings of the dry and wet bulb thermometers, the quantity of water vapor given off by the animal can be computed. The quantity of methane exhaled is found by determining the amount of carbon dioxide produced by the combustion of a specimen of air. The amount of oxygen consumed is deduced from analyses of the air at the beginning and end of the experiment. This analysis is trustworthy to within 1/100 per cent of the volume of air. If the whole apparatus contains 80 cubic meters, this uncertainty represents 8 liters of oxygen, which is almost negligible in comparison with the consumption of 2,000 to 3,000 liters in twenty-four hours. Larger errors are caused by uncertainty in the estimation of temperature and pressure in the respiration chamber. An error of 1/10 deg. C. in the mean temperature involves an error of about thirty liters in the estimation of the oxygen consumed. Such an error, equal to 1 per cent of the total amount of oxygen consumed by a horse or a cow in twenty-four hours, is possible, despite all precautions.

The diminution of pressure caused by the consumption of oxygen is compensated by the admission of oxygen from a weighed cylinder of compressed oxygen. Food is introduced through an air lock *S* and men can enter through another airlock. The capacity of the locks being known, allowance can be made for the air lost in their operation.

One of the questions which this apparatus should aid in answering is that of respiration through the skin and bowels. Intestinal respiration is very important in ruminants, from 6 to 10 per cent of the carbon transformed in the body being excreted as methane produced by fermentation in the intestinal canal, while large quantities of carbon dioxide, which in the old methods of experiment could not be separated from that exhaled from the lungs, are generated in the first stomach and the colon. The lungs can be connected with the external atmosphere by the pipes *J* and *E* (Figs. 1 and 3) so that only the cutaneous and intestinal exhalations can mingle with the air of the chamber. Thus the influence of diet on intestinal fermentation and the effect of temperature, humidity and muscular exertion on cutaneous respiration can be studied closely.

A second problem concerns the influence of various climatic factors on respiration, transformation of energy, excretion of water and capacity for work. Any desired temperature within very wide limits and any degree of humidity from saturation to less than 25 per cent, corresponding to a desert climate, can be maintained in the respiration chamber. It is also easy to expose the animal to a strong wind produced by blowers and to an illumination equal to that experienced on sun-lit Alpine glaciers. Radio-active emanations, winzation, and the intense electrostatic forces which occur on mountain peaks may also be employed. The rare atmosphere of mountain regions cannot be imitated, but its most essential feature, diminution in the supply of oxygen, can be reproduced. In experiments already made the proportion of oxygen has been reduced to 17 per cent, corresponding to an altitude of more than one mile. In a smaller apparatus, constructed for small animals, the air pressure can be reduced to less than ½ atmosphere.

A third object of study is the muscular efficiency of men and animals, and its relation to the consumption of food. The fitness of various animals for various kinds of work, the effect of training and the most effective methods of harnessing can be subjected to quantitative tests.

Practical Application of Meteorology to Aeronautics—II*

What the Meteorologist Can Do for Flying and Airshipping

By W. H. Dines, F.R.S.

Concluded from Supplement No. 1856, page 80

THE ordinary spherical balloon being absolutely at the mercy of the wind, can only go where the wind takes it. By rising or falling it may get into a current of air blowing from a different point to that of the surface wind, and hence it becomes of importance to know what change of direction and what change of velocity may reasonably be expected in the upper currents. It may be stated at the outset that to foretell the change with certainty is an absolute impossibility, but certain rules that generally hold can be given. Almost every wind that blows at an inland station will be found to be stronger at a few hundred feet than at the surface. As a general rule it will be found that if you face the surface wind, the wind above will come somewhat from your right hand. Suppose a balloon is at a height of 2,000 feet. An east wind is not likely to increase much in strength above this height, but a south-west or west wind is likely to do so. A south-east wind on the surface is fairly certain to turn to a south, and then to a south-west wind at a moderate elevation, and a north wind may draw into a north-west, but is not so likely to do so. As a rule for winds other than north a change of two points of the compass in direction and a doubling of the velocity may be expected between the surface and 3,000 feet, excepting during a hot sunny day in spring and summer. On such days a general mixing of the air by convection currents tends to equalize the different strata, and the velocity at the surface will not be greatly less than that above. At night calm mostly prevails in the lower strata if the sky be clear, and this is particularly the case on frosty nights, and even days, too, in winter. But there is hardly a rule without an exception, and I have met with exceptions to all the above rules.

The above remarks are not deduced from any tabular matter but are the result of my own observations and experience obtained during some thousand or so kite ascents made during the past eight years.

An airship is not so entirely at the mercy of the wind as a spherical balloon, but it is still far too much at the mercy of the wind. This is particularly the case with regard to starting and landing, and it is probable that no airship could be got into or out of its shed if even a moderate breeze were blowing transversely to the axis of the shed. The situation for these sheds should be very carefully chosen so that there may be as much shelter as possible from the wind. The best shelter is perhaps obtained by a broad belt of tall trees for there is always good shelter on the lee side of a wood, whereas a valley with steep sides is often a very playground for the winds, and a shallow valley with gentle slopes is but little better than an open plain.

A flying machine is less dependent in one way upon the action of the wind, but it is more so in another. In discussing the action of the wind it is necessary to define very carefully what we mean by wind. I am disposed to class wind under two headings, one which I may call the theoretical or mathematical wind, and the other, which I call simply wind and which is met with in ordinary practice. By the theoretical wind I mean the motion of the air such that every particle of air is moving uniformly, in the same direction, and with the same velocity as its neighbors. Such a wind does not exist in nature, but may be closely approximated to on some occasions by winds in the upper strata, and to a less extent by winds over the open sea. The action of such a wind on a flying machine is to carry it in its own direction and thereby to alter immensely the time required to go from one place to another, but such a wind, no matter at what speed it may be blowing, will not have the slightest effect upon the stability of the machine when it has once left the ground. It would, indeed, if its velocity were about the same as that of the machine, render starting and landing easy, but otherwise the airman, if owing to darkness or clouds, he could not see the earth, would be totally unconscious of its existence. I know that this must be a hard saying to those without mathematical training and who have not had to study many problems involving relative motion.

Although this theoretical wind does not exist in nature it is a thing of daily occurrence by artificial means and is met with by every passenger in a railway carriage or cabin in a steamer. In such cases, assuming the windows shut, all the air particles are traveling uniformly and the traveler is quite unconscious of their motion. A fly, flying about in the carriage, is equally unconscious, and is in exactly the same position as the flying machine in the hypothetical wind. On the steamer the passenger may go on deck, and if it chances that the steamer is a very fast one and there is a strong wind from directly behind, he will hardly be conscious of any wind, excepting from the roughness of the sea.

But the real wind is very different, particularly at inland stations and on certain days. No two air particles appear to be moving with the same velocity or in the same direction and any light article exposed to the wind is carried first to one side then to the other; first up, then down. Two anemometers have been placed side by side some eight feet apart and it has been found that the wind velocity at the head of one may for a second or two be double that of the other. It is this sort of wind that is fatal to any aeroplane, but it is this sort of wind that has to be encountered. Of course, so long as the wind is light, the variations in its strength are trifling and unimportant, but light winds and strong winds seem to be subject to the same percentage variation in velocity and with a strong wind the actual variations are large.

It seems to me that progress in the art of mechanical flight depends largely upon meeting and overcoming this difficulty of the gustiness of the wind, and the first point is to know precisely what has to be met. It has been my business to fly kites at all season and in all kinds of weather for many years for the purpose of obtaining observations for the Meteorological Office, and during the process the irregularities of the wind have been impressed upon me by much unpleasant experience, still I hope that some information has been obtained that may be of use. Some seven

* Paper read before the Aeronautical Society of Great Britain.

years ago I attached to my apparatus a clock and drum on which the tension of the wire holding the kite was automatically recorded, and the arrangement has been in regular use ever since. In general the pull becomes much steadier as the kite rises, and this for two reasons: First, with an exception to be presently noted, the wind becomes much steadier with increasing height; secondly, with more wire out an efficient spring is provided by the stretching and the sag of the wire. But I have reason to think that the smoother curve is but slightly due to the spring of the long wire. The exception mentioned is the strata where small curling and fleecy clouds are being formed. At whatever height these special clouds are found at that height the tension of the wire is always jerky notwithstanding its capabilities as a spring, hence it seems likely that the spring of the wire will not in any case suffice to smooth down the curve unless the wind be steady. In bad weather at Pyrton Hill a small kite of 44 square feet sail area is used. It is said that if a kite can be got safely through the gusty surface wind it will fly safely in the steadier wind above, but such is not our experience. We find that the chance of a kite being broken or diving is under average conditions about equal at all heights up to 3,000 feet. With a different type of kite it is quite likely that a different conclusion might be reached. The wind near the surface is far more gusty, but the wind above is far stronger, and the two matters seem to about balance each other. From the automatic traces it appears that the maximum pull on the wire, and it is on this that a breakaway depends, is about the same at all heights.

In a recent observation the wind velocity at the highest point was shown by the anemometer attached to the kite to be 50 miles an hour. Fifty miles an hour corresponds to force 9 on the Beaufort scale, a strong gale, and although common enough on the coast, or at least on the western coasts, it is very seldom experienced inland in the south-east of England.

In fact at Kew in some years even force 8 is not reached. Anyway it is certain that the kite and wire that gave the result if sent up in a surface wind represented by force 9 could not have survived five minutes, yet the kite flew quite steadily and well in this wind at a height of about 2,500 feet. This appears to afford conclusive evidence of the steadiness of the upper wind compared with that of the lower, for the change of density at 2,500 feet is unimportant.

Observations have been taken that show the change in the direction of the wind from minute to minute at various heights. They show also the change as the height increases; also the peculiar sudden veering at a small height and then steady backing of the wind as the height increases which is not at all what might be expected; also show changes in altitude, which represent the angular elevation of the kite, but not necessarily any upward and downward motion in the atmosphere, for changes, such as they are, may certainly be produced by changes in the horizontal velocity.

It is, however, perfectly certain that vertical currents exist. The ordinary angle of our kites in a good steady breeze is between 60 and 65 degrees, but it is very common to get angles well over 70 degrees for a short time. Also at times a kite may fly almost overhead with quite a slack wire. This may last for a minute or more, and can only be produced by an air current with a vertical component strong enough to lift the weight of the kite.

I think the evidence and considerations given above should be sufficient to convince you that a steady uniform wind will give no difficulty to the management of a flying machine excepting as an obstacle to flying in a certain direction, but that the danger produced by wind is solely due to the irregularity of the wind; and the question at the present time is how this can be met.

It certaintly cannot be met by any mathematical analysis which might show how to build an aeroplane of a stable form, for the problem is hardly solvable for the case of a dead calm, and a perfect fluid, and is at present quite beyond the range of mathematics when the air is taken to be a viscous fluid and subject to turbulent motion.

The solution must come from the practical and experimental side, but how?

A very similar problem has confronted the kite flyer, and I think I may say it has been partially solved.

Still the cases are widely different, for the kite flier in case of an accident loses his apparatus, but that is a very different thing to losing his life. My ideal has long been to obtain a kite that could be taken out in any weather except calms and light winds, sent up to a height of at least 3,000 feet with a meteorograph inside, and then drawn back to its starting point with reasonable certainty, with such certainty that is as a passenger to France may have of finding a boat to take him safely from Dover to Calais. No one knows better than I that this ideal has not been realized, we can perhaps send up a kite and meteorograph to 3,000 feet in any weather, but the getting back is not so certain. Still, since January, 1908, about 300 kite ascents have been made at Pyrton Hill, mostly in the winter and mostly to heights exceeding 3,000 feet, and twice only have we failed to bring back the kite undamaged to the starting point. This result has not been secured by omitting days of strong wind, for very few days have been omitted on account of such winds. Years back we expected an accident about once a month, and our expectations were seldom disappointed. The improvement has been due to gradual modification and improvement in the details of the kites. The parts that used to break have been made stronger, and other parts where experience showed that less strength was required have been lightened, so as not to increase the total weight. The process was necessarily slow, because when a kite broke in the air and then dived to the ground, it was hard to know which part of the general wreck was responsible for the dive. Our present kite is almost identical with the old ones in shape and size, but some important modifications have been made. The edges of the bad weather kite have been made circular instead of straight. It is probable that the rectangular shape is the more stable but the straight edge is liable to turn over and the curved edge cannot do so. Powerful springs have been introduced into the bamboo struts that extend the kites and these springs have greatly increased the general reliability, the material is now stretched with a nearly uniform degree of tension, no matter how the hygrometric state of the air may change, also the elasticity of the springs affords a good protection against damage by sudden gusts of wind. The two bamboos are not now lashed together where they cross each other, but the long one slides through a ring fixed on the short one. The ring prevents the long bamboo sagging and giving way under the thrust, and since the bamboo can move longitudinally, there is perfect uniformity in the tension of the material on the two sides of the kite.

Mr. Lanchester has shown from the theoretical side that for stability an aeroplane should have a small moment of inertia and this is certainly requisite for a good kite. The points to be attended to are first a stable shape, then ample strength in every part to meet the strain that may come upon it, perfect symmetry, and a small moment of inertia. The second and fourth requirements are mutually opposed to each other, and perfect symmetry is in practice very difficult to obtain.

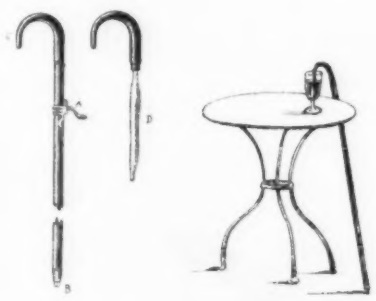
The requirements for a good aeroplane are doubtless very similar, but I must say that the shape of all the machines that I have seen appears to me to be the very reverse of stable.

Numerous accidents have occurred with flying machines. It is inevitable that accidents should occur, and all honor is due to those who are willing to take the risks. Still one cannot help feeling that the long death-roll is partly due to the spectacular and commercial element that has been so prominent. The weather conditions in England being what they are the chance of obtaining suitable weather for an aviation meeting on fixed dates is small unless perhaps the time were fixed for 7 P. M. to 7 A. M. during the summer nights. There are plenty of calm days in England but their occurrence cannot be foretold.

I should like to add a few words on another point. It is said from theoretical considerations that great speed conduces to stability. Could aeroplanes be made of boiler-plate this might be true, but in practice I believe that the exact opposite is true, and I should like to see prizes given for the lowest instead of for the fastest speed. When progress has been made and it is easy to land and start in any moderate-sized open space it will be time enough to increase the speed, and then it will be easy enough to do so with more safety.

A Drinking Cane

A CANE which has the amazing propensity of imbibing the contents of a glass of inebriating fluid presented to it might perhaps be a useful article to certain individuals whose calling exposes them to constant invitations to partake of such refreshments, invitations which their sense of politeness and incidentally their business interests often forbids them to refuse. Perhaps, however, the principal function of



A DRINKING CANE

the little device depicted in our illustration will be to provide harmless amusement and mystification.

The construction of the article is extremely simple. It is, of course, hollow and perforated at the handle end. It contains a rubber tube *D* controlled by an inconspicuous lever *A*. The operator, by pressing upon this lever, forces a quantity of air out of the tube *D*, and upon submerging the opening at the end of the cane under the surface of a liquid, and thereon releasing the lever *A*, a siphon action is started, and the liquid then continues to flow until the vessel is exhausted. The cane can be unscrewed and emptied of its contents, and is then ready for repeated operation.

A High Frequency Meter

ONLY about 30 sparks per second can be sent as separate sparks between the zinc or cadmium electrodes which were formerly used in wireless transmitters. If the frequency is increased further the spark gap has not sufficient time between successive sparks to regain its original high resistance. Hence the sparks run together and form a continuous flaming arc, which is useless for the production of electric waves. The spark-gap and oscillatory circuits now

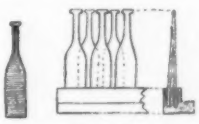


Fig. 1.

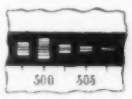


Fig. 2.

employed produce a more rapid succession of sparks, the frequency attaining thousands per second in the case of the singing arc. If the frequency of the alternating current which maintains the singing arc does not exceed 300 per second, it can be measured with convenience and accuracy, by means of the old form of the Hartmann-Kempf frequency meter. In this instrument an electromagnet energized by the alternating current acts upon a series of steel reeds and sets into vibration that particular reed whose period accords with that of the current. Hartmann and Braun have recently succeeded in overcoming the difficulty of constructing reeds of very high pitch which can be set into visible vibration by an electromagnet, and have produced a meter for frequencies as high as 5,000 per second. In the new instrument each reed has the form of a bottle (Fig. 1), covered by a white plate, the edge of which appears of greater or less

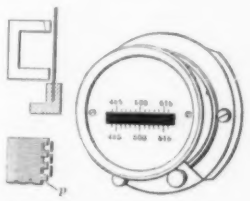


Fig. 3.

thickness according to the amplitude of vibration (Fig. 2). These edges are seen against a dark background through a slit in the front of the case, on which a scale of frequency is engraved (Fig. 3).

Radioactivity of Snow

IT has been known for some time that newly-fallen snow is radioactive, but until recently, when some French scientists looked into the matter, the subject had not been examined very closely. The investigators announce that snow quickly gathered after its descent to the earth is highly radioactive, but that this quality disappears almost entirely after the lapse of two hours. Snow which has fallen on the soil appears to retain its radioactivity a little longer than that which has come to rest upon the roofs of buildings.

A Grain Tester for Commercial Use

A Moisture Tester for Grain and Other Substances and How to Use It

By Dr. J. W. T. Duvel

INTRODUCTION.[1]

THE apparatus described herewith, which is known as the Brown-Duvel moisture tester, was developed primarily to meet the demands of grain dealers for a rapid and exact method of determining the moisture content of commercial corn. Since that time some slight modifications have been made in both the apparatus and the method, and specific instructions have been worked out for making moisture tests of the more important cereal grains and some of the more important seeds. It has been demonstrated that the method is entirely practicable for making moisture determinations of practically all substances which admit of a free circulation of the oil during the heating.

Both the construction and the process have been made as simple as possible, so that reliable tests can be made by any careful worker, even though he has not had the benefit of special training in a chemical laboratory. It is, however, of the utmost importance that the operator be a careful and honest worker who can be depended upon to follow simple instructions and to report results correctly. It must be borne in mind that the instructions are applicable only when used in connection with the moisture tester herein described and illustrated and do not apply to modified forms of testers.

DESCRIPTION OF THE APPARATUS.

The apparatus consists of a heating chamber divided into compartments so that a number of samples can be tested at the same time, a tank for cold water, through which the condenser tubes pass, and a suitable stand for supporting the heating chamber and cold-water tank, together with numerous accessories, such as thermometers, distillation flasks, graduated measuring cylinders, etc., all of which are illustrated and described somewhat in detail, so that no one should have difficulty in setting up the apparatus and in making the tests properly.

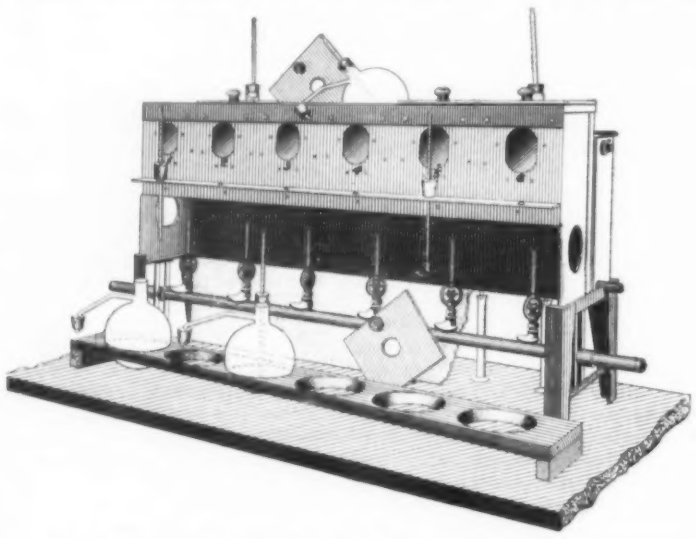


FIG. 1.—Six-compartment Tester, With Wooden Rack in Foreground.

Fig. 1 shows an external view of a standard six-compartment moisture tester set up ready for use. Each compartment of the heating chamber is numbered and provided with a small mica window, through which the operator can observe the action within the flask while the test is in progress. Fig. 2 is a cross section through one of the compartments of the tester, showing the position of the flask and the flask support within the compartment, the adjustment of the thermometer, and the proper connections of the various parts.

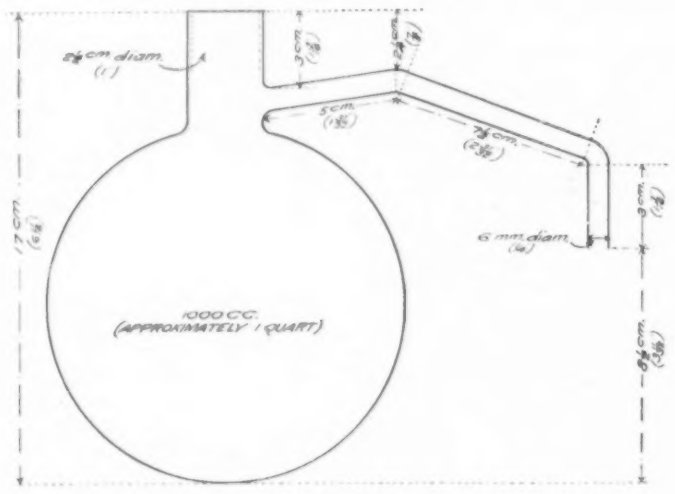


FIG. 5.—Distillation Flask.

Figs. 1 and 2 show testers equipped with burners for using gas as fuel. The form of construction, however, is such that alcohol or gasoline burners can be used with equally good results, provided the burners give a pointed rather than a spreading flame and the apparatus is modified in no other way.

THERMOMETERS.

It is of the utmost importance that the thermometers be of extra quality, and not the ordinary grade of chemical thermometers which are so commonly furnished with apparatus of this general character. The success of this method of making moisture determinations depends largely upon the accuracy with which the temperature readings are made, and any thermometer showing an error of more than one-half of a degree should not be used unless such errors are known and provided for in the readings.

It is also necessary that the mercury bulbs of the thermometers be of approximately the same length, so that some uniformity can be had as to the depth to which the thermometers are immersed in the oil, the correct positions of which are shown in Fig. 3.

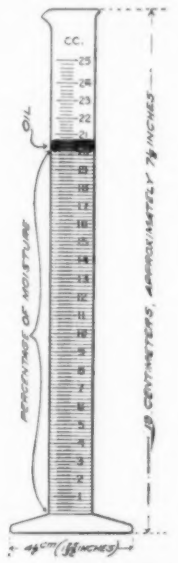


FIG. 3.—Graduated Measuring Cylinder, Showing 20 Per Cent of Moisture.

FIG. 4.—Swab or Test-Tube Cleaner Having a Small Sponge Attached to the End of a Rod.

Specifications for Thermometers.

In order to secure a high-class thermometer at a minimum cost it has been found advisable to adopt a thermometer which can be used for general laboratory work. The thermometer should be graduated in whole

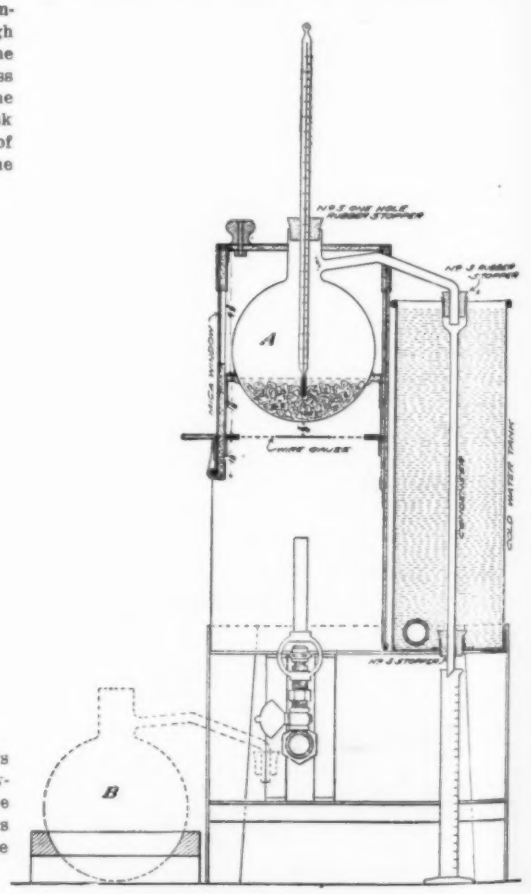


FIG. 2.—Sectional View, Showing the Various Parts Properly Connected for Use. *A*, Distillation Flask in Position, Three-eighths of an Inch Above the Wire Gauze; *B*, Distillation Flask in Wooden Rack, Used Only During Filling.

[1] This material was prepared for the United States Department of Agriculture in order to provide specific instructions for making moisture determinations of different substances and to bring about more uniformity in the use of the apparatus. The use of this moisture tester with corn has resulted in more attention being paid to the proportion of dry matter contained therein, and already considerable quantities of corn are being sold on a percentage statement of moisture or on grades in which the percentage of moisture is limited, and it is believed that the time is not far distant when this will be the universal practice. The apparatus described was developed by Mr. Edgar Brown and Dr. J. W. T. Duvel, of this bureau, and has been patented by them in order to secure its free use by the people of the United States.—WM. A. TAYLOR, *Acting Chief of Bureau.*

degrees from 0 to 200 deg. C., with the graduations etched on a stem having a white background. The diameter of the stem of the thermometer should be nine thirty-seconds of an inch, so that it will fit properly in the No. 5, one-hole, rubber stopper. The length of the mercury bulb should be approximately three-

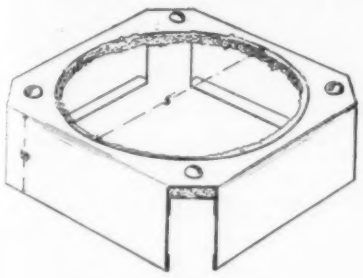


FIG. 6.—Flask Support.

fourths of an inch—not greater than thirteen sixteenths nor less than eleven-sixteenths of an inch. The total length of the thermometer should not exceed 13 inches.

The manufacturers should be required to furnish certificates of correction with all thermometers show-

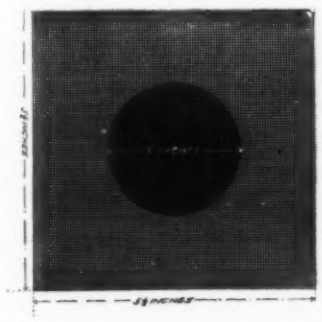


FIG. 7.—Wire Gauze With Asbestos Center.

ing errors in calibration and graduation exceeding one-half of a degree at 175 and 190 deg. C.

GRADUATED MEASURING CYLINDERS.

The small graduated cylinders for measuring the moisture should have a capacity of at least 25 cubic centimeters. They should be carefully graduated in fifths, so that the readings can readily be made in tenths. When 100 grams are used for the test, the number of cubic centimeters of water in the graduate

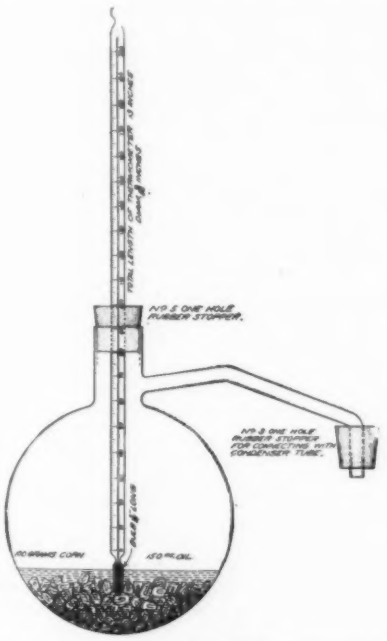


FIG. 9.—Distillation Flask, Showing the Correct Adjustment of the Thermometer.

corresponds to the percentage of moisture originally contained in the sample. If only 50 grams are used, as is necessary with some substances, the number of cubic centimeters of water in the graduate is equivalent to one-half of the moisture percentage.

In making moisture determinations a small quantity of oil—usually less than one-half of a cubic centimeter—is carried over into the measuring cylinder and collects on the surface of the water, so that the readings should be made at the bottom of the meniscus between the oil and the water, as shown in Fig. 3. Should the oil and the water not separate readily, the graduated cylinder should be whirled by rolling quickly between the two hands.

After each test the cylinders must be cleaned and dried, which can best be done with a swab or test-tube cleaner having a small sponge attached to one end, as shown in Fig. 4. Satisfactory cleaners can also be made as needed by twisting cotton waste, strips of cheesecloth, or some other similar substance, about one end of a piece of fairly heavy wire.

DISTILLATION FLASKS AND FLASK SUPPORTS.

The special distillation flasks, with a capacity of approximately 1,000 cubic centimeters, should be made of the best grade of resistant glass, and should be well annealed in order to withstand sudden changes in temperature without breaking. The necks of the flasks should be sufficiently heavy to stand tight corking. Fig. 5 shows one of these flasks in which the dimensions of the different parts are given in both centimeters and inches.

In some instances dealers have supplied flasks showing such wide variations in the dimensions that they were entirely useless. It is therefore recommended that in ordering flasks it be definitely stated that they must be in accordance with the specifications given in this article. In case the dimensions of the flasks,

FIG. 10.—Strainer for Recovering the Oil.

as well as other parts of the apparatus, are not approximately as herein specified, they should be returned.

The pipestem triangles originally used for supporting the flasks above the wire gauze resulted in the breakage of an undue number of flasks, and for that reason these triangles have been replaced with removable supports, as shown in Figs. 2 and 6. This form of support provides a good asbestos ring on which the flask rests, exposes the bottom of the flask more uniformly to the action of the heat, and at the same time is so made that a sufficient quantity of heat comes in contact with the upper part of the flask.

In adjusting these supports the asbestos ring in the top of the support should be cut so that the bottom of the flask will be not less than three-eighths of an inch above the asbestos center of the wire gauze, as shown in Fig. 2. The support should be 1⅞ inches high.

WIRE GAUZE.

The wire gauze in the bottom of each compartment between the flask and the flame should be kept in good condition, so that the flame does not play directly on the bottom of the flask. This gauze should be made of iron wire, from sixteen to twenty thousandths of an inch in diameter, with 20 wires to the inch and with a 2-inch asbestos center, as shown in Fig. 7.

The asbestos center insures a more uniform distribution of heat and adds greatly to the life of the wire. It can readily be put in by mixing asbestos cement with water and rubbing it into the mesh of the gauze.

CONDENSER TUBES AND RUBBER STOPPERS.

The glass condenser tubes, with dimensions as shown in Fig. 8, should be so adjusted in the No. 5 rubber stoppers that when the latter are firmly pressed into the holes in the bottom of the cold-water tank the tops of the tubes will be approximately one-fourth of an inch above the top of the tank.

The No. 5, one-hole, rubber stoppers which carry the thermometers and the No. 3, one-hole, rubber stoppers used on the side tubes of the flasks, should be of such quality as will withstand comparatively high temperatures and resist the action of the oil. Stoppers containing a large percentage of pure gum are not desirable. They soon swell and become unfit for

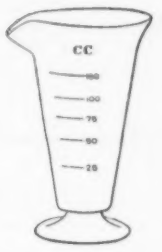


FIG. 11.—Oil Measure.

use. Before attempting to put any of the glass parts through the holes in the rubber stoppers they should be moistened with oil or water, thereby lessening the chances of breaking the tubes and cutting the hands.

GENERAL DESCRIPTION OF THE METHOD.

The method consists in heating whole grains, seeds, spices, or other similar substances in a mineral oil

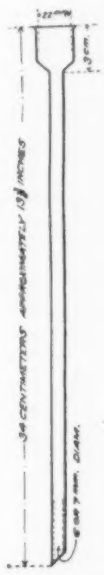


FIG. 8.—Condenser Tube, Shown Occupying the Axis of the Cold Water Tank in Fig. 2.

FIG. 12.—Improved Oil Measure. Each Number on the Glass Gage Represents 150 Cubic Centimeters of Oil.

having a flashing point much above the boiling point of water, in condensing the water which distills off, and in collecting and measuring it in a suitable graduate. The method, as already stated, is so simple that the tests can be made by any careful worker who is able to follow simple instructions.

A single moisture determination can be made in twenty-five or thirty minutes, and with a six-compartment tester, as shown in Fig. 1, six tests can be made

FIG. 13.—Balances With a Set of Polished Brass Weights, 400 Grams to 5 Grams. Left, Torsion Balance; Right, Trip Scale With Agate Bearings.

in approximately the same time. In commercial work, where a large number of tests are to be made, one man and a helper, with the use of three six-compartment machines, can readily make 200 or more tests in a day of eight hours, an average of less than two and one-half minutes for each test. In addition to the rapidity with which moisture determinations can be made by this method, it is especially valuable in testing substances which have a large percentage of water,

are difficult to grind, or contain such large quantities of volatile oils that determinations based upon differences in weight during drying are unreliable. This method also obviates the grinding of samples, thus eliminating the loss of water which accompanies the grinding of material of relatively high moisture content. Moreover, ground material has a tendency to "cake" in the flask; consequently, this method is not entirely satisfactory for making moisture determinations of flour, meal, powders, or other similar substances, without some further modification.

HOW TO MAKE A TEST.

After properly mixing the bulk sample, carefully weigh the desired quantity for the moisture test and empty immediately into the distillation flask, to which add the oil and shake, with a slight whirling motion, until the two become well mixed. Grasp the neck of the flask in one hand and hold it in such a manner that when the No. 5 rubber stopper carrying the thermometer is inserted it can be readily determined whether the mercury bulb of the thermometer is properly adjusted in the oil, as shown in Fig. 9. Place the flask in the proper compartment of the tester and proceed in a similar manner with the remaining samples.

The correct adjustment of the thermometer is a factor which must not be ignored. If the mercury bulb of the thermometer is too near the bottom of the flask the percentage of moisture will be too low. For the same reason it is important that there be some uniformity in the length of the mercury bulbs of the thermometers, which should be approximately three-fourths of an inch.

As the thermometer is being inserted, glance along the side tube of the flask to make certain that it has not become stopped by the lodgment of some particle while emptying or filling the flask. If the side tube is not open to permit the free escape of the rapidly forming steam the pressure during the heating will become sufficient to blow out the stopper and thermometer, or possibly to burst the flask.

When the flasks have been filled and placed in the compartments of the tester, connect the side tubes of the flasks by means of the No. 3 rubber stoppers with the thimbles of the glass condenser tubes which extend down through the cold-water tank, so that the moisture which is liberated from the grain or other substance will be condensed and collected in the graduated cylinders beneath the tank. Fig. 2 shows the correct manner of adjusting the various parts of the apparatus.

Place the cover over the flask, then ignite the gas, adjusting the flame so that it will require about twenty minutes to reach the temperature prescribed for the substance being tested. When the desired temperature is reached extinguish the flame quickly, after which the thermometer will show a slight gradual increase in temperature. If the sample contains a large percentage of moisture there is danger of boiling over, but this can usually be prevented by lowering the flame whenever the action in the flask becomes too vigorous, as can be readily determined through the mica window in the front of the compartment. As soon as the water stops dropping from the condenser tube, which usually requires from four to six minutes after the flame has been extinguished, the test is complete. However, before reading the amount of moisture remove the covers and then disconnect the flasks from the condenser tubes in order to allow the small quantity of moisture which sometimes collects at the base of the No. 3 rubber stoppers to drop into the graduated measuring cylinders. The percentage of moisture is read beneath the layer of oil on top of the water, as shown in Fig. 3. In order to guard against possible error it is desirable to make duplicate tests of all samples and take the average of the two readings as the correct percentage of moisture.

While the contents of the flasks are still hot, take the flask by the side tube, and after giving a slight whirling motion invert quickly, emptying the contents into a suitable strainer, so that the oil can be recovered for further use.

When the flasks are not in use, keep them in place in the compartments and make all connections the same as for a test. In using a new flask for the first time, "run" a preliminary sample previous to making a regular test, so that all the flasks will be in uniform condition.

HOW TO TEST DIFFERENT SUBSTANCES.[2]

Detailed instructions have been worked out for making moisture determinations of a limited number of substances, as follows:

Barley.—Use 100 grams of grain and 150 cubic centimeters of oil, and extinguish the flame when the thermometer registers 190 deg. C.

Corn (maize).—Use 100 grams of grain and 150 cubic centimeters of oil, and extinguish the flame when the thermometer registers 190 deg. C. This method, however, can not be used with the pop corns.

Corncobs.—Use 50 grams of cob cut in pieces that can be easily removed from the flask and 250 cubic centimeters of oil, and extinguish the flame when the thermometer registers 190 deg. C.

Cottonseed.—Use 50 grams of seed and 150 cubic centimeters of oil, and extinguish the flame when the thermometer registers 190 deg. C.

Flaxseed.—Use 100 grams of seed and 150 cubic centimeters of oil, and extinguish the flame when the thermometer registers 175 deg. C.

Kafir.—Use 100 grams of grain and 150 cubic centimeters of oil, and extinguish the flame when the thermometer registers 190 deg. C.

Oats.—Use 50 grams of grain and 150 cubic centimeters of oil, and extinguish the flame when the thermometer registers 195 deg. C. In oats that are light and chaffy special care should be taken to insure the thorough mixing of the oil and grain and to heat with a slower flame in order to reduce the foaming to a minimum. In extreme cases it may be necessary to add an extra 50 cubic centimeters of oil.

Rice (unhulled).—Use 100 grams of grain and 150 cubic centimeters of oil, and extinguish the flame when the thermometer registers 190 deg. C.

Rye.—Use 100 grams of grain and 150 cubic centimeters of oil, and extinguish the flame when the thermometer registers 175 deg. C.

Soy bean.—Use 100 grams of beans and 150 cubic centimeters of oil, and extinguish the flame when the thermometer registers 170 deg. C.

Wheat.—Use 100 grams of grain and 150 cubic centimeters of oil, and extinguish the flame when the thermometer registers 180 deg. C.

OIL FOR THE MOISTURE TESTS.

In making tests a good grade of mineral engine oil should be used. The oil must be free from water, should have a flashing point in open cup of approximately 200 to 205 deg. C. (392 to 401 deg. F.), and preferably a viscosity between 10 and 15 (Engler) at 20 deg. C. (68 deg. F.). The higher the viscosity the greater the danger of boiling over, and for this reason cylinder oils should not be used; as a rule, they are too heavy for good results.

After the tests are completed and while the oil is still hot, empty the contents of the flasks into a strainer to recover the oil, which can be used repeatedly. A funnel strainer fitted to the mouth of a 3 or 4-gallon milk can, as shown in Fig. 10, is serviceable and inexpensive.

MEASURING THE OIL.

A conical glass graduate, as shown in Fig. 11, having a capacity of 150 cubic centimeters, is ordinarily used for measuring the oil for the test. A more complete device consists of a graduated glass gage and a stopcock fitted to a cylindrical brass cup of a size to hold sufficient oil for at least a dozen tests, as shown in Fig. 12.

DRAWING AND HANDLING SAMPLES.

It is admitted that to secure a representative sample is often very difficult, but the necessity of sparing no trouble in this respect is most strongly urged.

In securing samples of grain from cars, etc., it must be remembered that, as a rule, grain from the surface will show less moisture than that in the body of the shipment. In corn in cars it is not uncommon to find differences of several per cent between the moisture content of the layer of corn immediately at the surface and that of the body of the grain directly beneath. In an experimental shipment of three lots of corn contained in a single car in which special care was taken to see that each lot was uniform throughout, moisture tests at destination, fifteen days after shipment, showed 14.1 per cent, 14.3 per cent, and 14.1 per cent for corn from the surface of each of the three lots, as compared with 17.3 per cent, 16.9 per cent and 19.2 per cent, respectively, for the samples taken with a grain trier from 2 to 3½ feet below the surface, the latter percentages being practically the same as at the time of shipment.

Likewise, the same care must be observed in handling the samples after they are drawn from the bulk or weighed for the test. If exposed to the air they will lose moisture in accordance with the condition of the atmosphere and the percentage of water in the sample. A preliminary test with 100 grams of wheat containing 14.5 per cent of moisture showed a loss of 0.20, 0.35, 1.10, and 1.90 per cent when exposed to the air of the laboratory for periods of one-half, one, four, and twenty-six hours, respectively. A second lot of wheat containing 16.1 per cent of moisture lost 0.50, 0.75, 1.75, and 3.20 per cent, respectively, during the same periods under identical treatment.

BALANCE FOR WEIGHING SAMPLES.

While not a part of the apparatus, a balance is necessary for weighing the samples. One of simple construction, having a sensitiveness of one-twentieth or even one-tenth of a gram, has been found quite satisfactory. Balances similar to the two types shown in Fig. 13, which have a special scoop for emptying the weighed samples into the distillation flasks, will meet all requirements. Such balances are likewise much less expensive, less likely to get out of order, and more easily operated than the delicate analytical balances commonly used in chemical laboratories.

Whatever the type of balance used, it should rest on a firm support, preferably a heavy shelf securely fastened to a solid wall of the building, which will greatly facilitate the keeping of the scale in balance, which is absolutely essential for reliable work.

SPECIAL POINTS FOR CONSIDERATION.

(1) The moisture tester should be installed in a place where it will not be exposed to strong air currents.

(2) The tester can be equipped for burning alcohol or gasoline, but gas is to be preferred whenever available.

(3) The wire gauze with asbestos center should be kept in good condition, so that the flame will not play directly upon the bottom of the flask.

(4) The bottom of the flask should be not less than three-eighths of an inch above the wire gauze.

(5) See that the column of mercury in the thermometer is continuous; if broken it should be shaken down.

(6) Adjust the thermometers in the rubber stoppers so that the bulbs of the thermometers will be approximately four-fifths immersed in the oil.

(7) Keep a good supply of cold water running through the condenser tank.

(8) Adjust the flame so that about twenty minutes are required to reach the prescribed temperature.

(9) If the moisture content of the sample is high, so that there is a tendency to boil over, lower the flame until a considerable portion of the water is distilled over.

(10) When the thermometer registers the prescribed temperature, extinguish the flame promptly.

(11) After the flame is extinguished a slight gradual increase in temperature is to be expected. A sudden increase or a sudden decrease in temperature of several degrees indicates that the flame was too intense during the latter part of the heating, and the test should be repeated.

(12) See that there is no water in the graduated cylinder before starting the test.

(13) Read the percentage of moisture in the graduated cylinder beneath the layer of oil on top of the water.

(14) If the water which distills over is discolored, the substance has evidently been burned and the test should be repeated.

(15) When not in use keep the flasks in position in the compartments, with all connections made as for making a test.

(16) Before making a test in a new flask, "run" a preliminary sample, so that all the flasks will be in uniform condition.

(17) Draw all samples carefully and keep them in air-tight containers until ready to make the test. They lose moisture rapidly when exposed to the air.

(18) Place the scales on a firm suport and see that they are in balance before making a weighing.

(19) The specific instructions for making tests given in this circular do not apply to modified forms of testers.

[2] Different substances are likely to require slightly different treatment, which can be determined only by careful experiments covering a wide range of conditions, checking the results with the tests made by drying a definite quantity to constant weight and calculating the loss in weight as the percentage of moisture. The data here shown were secured by checking the results with moisture determinations made by drying to constant weight in the common type of double-walled oven filled with water maintained at the boiling point, except that the proper treatment for flaxseed was determined by checking with samples dried to constant weight in a 28-inch vacuum at a temperature of 99 deg. to 100 deg. C. Moisture determinations made in vacuum at temperatures of 105 deg. or 108 deg. C. will show higher percentages than will result from the method herein described.

The Stick Insect

BEFORE the recent Conversazione of the Royal Society at London, Dr. G. H. Rodman exhibited a series of stereoscopic transparencies illustrating the life history and minute structure of the stick insect.

Stick insects are natives of warm climates (India, Australia, the Malay Peninsula), but with care they may be reared in this country. They resemble, as their name suggests, portions of stick, and they afford an excellent example of mimicry.

The feet are provided with a pair of sharp hooks by which they can cling to rough surfaces, and also with a pad or sucker, which enables them to get a foothold on perfectly smooth surfaces.

The eye is a compound one, and faceted. It can be covered at will by the insect extending his forelegs directly forward in the long axis of his body.

Practical Aspects of Printing Telegraphy—II*

An Inventor on the Difficulties to be Encountered and the Way to Overcome Them

By Donald Murray, M.A.

Continued from Supplement No. 1856, page 76

DIFFICULTIES IN GENERAL.

THE printing telegraph inventor has to dance in chains, which are none the less heavy because they are invisible. He has to conform to most intricate and unexpected conditions, and although the telegraph administrations are benevolently disposed, and do all they can, in the public interest, to assist in the development of printing telegraphy, they are still bound to look at the matter from the financial point of view, and to insist on a printing telegraph showing either (1) a saving of labor, or (2) a saving of line, or (3) a saving of time in transmission, or if possible all three. In fact, we may say that the difficulties in the way of introducing printing telegraphs are essentially commercial. The employment of printing telegraphs involves a considerable increase in the cost of office equipment, and there must be a substantial justification for that expenditure in the shape of saving in line, labor, or time. The most attractive feature in the eyes of the majority of telegraph administrations is the saving of labor, and the saving of labor by means of a printing telegraph is a peculiarly intricate problem. Time and labor saving in telegraphy are often antagonistic, and in this case we have to face one of the maximum problems, of which there are so many in our modern civilization. We have to calculate and balance out the gains and losses of time and labor so as to get the maximum benefit.

As a practical illustration we may take the question of automatic tape transmission of signals versus direct transmission. This happens to be one of the most important of these maximum problems—these compromises between time, labor, and line saving. At the first glance direct transmission seems to be the best, and most printing telegraph inventors have adopted this plan, but it is not the most economical, and it is not necessarily the quickest. Take the case first of direct transmission on a keyboard limited to, say, 40 words a minute. The operator's maximum speed is limited to 40 words a minute, and his average will certainly not be more than 30, apart from any stoppages to decipher badly written messages, to pick up and lay aside messages, and to sign and time them. All these delays on the part of the operator mean loss of time on the line and diminished carrying capacity for traffic, unless a second operator is assisting him so that he may send continuously. This plan, however, means waste of labor. On the other hand, with automatic perforated tape transmission on a transmitter running at 40 words a minute there are none of these delays. Transmission is continuous, and the operator working on a keyboard perforator finds no limit to his speed of operation. His short stoppages do not stop transmission, which is continuous. Actual trials on the Murray multiplex at 40 words a minute show that an operator can do double as much work with automatic tape transmission as with direct transmission. Not only is there 100 per cent increase in the efficiency of the labor, but there is corresponding increase in the carrying capacity of the line. Also, although it may be said that there is a minute or so extra delay in perforating a message before transmission, and that therefore direct transmission saves time, this is not the case if there is pressure of traffic, because automatic tape transmission, by increasing the efficiency of the operator and the carrying capacity of the line, clears off traffic more quickly.

The only alternative in the case of direct transmission keyboards is to speed up the machinery from, say, 40 words a minute to, say, 80 words a minute. In this case the speed of the keyboard is above the maximum speed of the average operator, and it is practically free, like a typewriter keyboard. In this case, therefore, the operator can deal with as much work as on a keyboard perforator for automatic tape transmission, but this advantage is only obtained by a great sacrifice of line-carrying capacity. One operator cannot average by the hour more than about 30 words a minute, so that the line is used at 80-word speed for a 30-word output. With automatic tape the 80-word speed would give two simultaneous transmissions of 40 words a minute each, and the carrying capacity of the line would be doubled. On circuits where the traffic is not heavy, and where the carrying capacity of the line is much above requirements, the speeding up of the direct transmitter is a practical plan, and will come into use on such lines, but not on lines where there is heavy traffic.

One of the fundamenal features of telegraphy is that a very large proportion of the total work must be performed by the human hand and mind. It can never reach the condition of a modern flourmill, where grain goes it at one end and flour comes out at the other with a minimum of labor. Telegraph messages cannot be made to flow along automatically in a steady stream under the watchful eye of a few supervisors. On the other hand, suitable printing telegraph machinery and the assistance of the telephone can greatly reduce the amount of labor at present required for handling telegrams. In small countries with dense populations like England, France, and Germany, time and labor saving are the most important points. In Europe the distances within each country are, in most cases, comparatively short, and the differences of language reduce the number of long-distance messages to a small fraction compared, for instance, with the long-distance traffic in the United States, especially when it is remembered that the United States has only a population of ninety millions and Europe has over three hundred millions. If Europe was a united one-language country the long-distance telegraph traffic would be enormous, and the printing telegraph problem in Europe would take on a very different aspect from what it has at present. Many difficulties that are now almost insurmountable would disappear. On the other hand, the telegraph traffic within each European State over comparatively short distances is often very heavy. Conditions in Europe are, therefore, different from the conditions in the large new countries. In Europe, excluding Russia, labor saving is most important, especially as the telephone has cut into telegraph traffic to such an extent that during the past few years the growth of telegraph traffic in most European countries has been small or nil. In Great Britain underground cables have increased the superfluity of telegraph wires for the time being. Hence Western European administrations have enough telegraph lines in most cases, and means of increasing the carrying capacity of the lines are not urgently required. On the other hand, the cost of maintenance of lines and the number of wires on poles are serious considerations that weight in favor of line saving.

In the giant new countries with magnificent distances, including the United States of America, Russia, Canada, South Africa, the Argentine, Brazil, and Australia, the saving of wire is of the greatest importance, and some waste of labor may be tolerated if there is compensating line saving. Here again we have a maximum problem. The relative advantages of line and labor saving have to be balanced to get the maximum benefit.

The foregoing considerations make it easy to understand that the amount of labor that must be performed by the human being, the head-work that cannot be done by a machine, in connection with commercial telegrams is always large, and in the nature of the case there can never be results in labor-saving like those in industries where the great bulk of the work is of a simple routine character easily performed by machinery.

THE LABOR-SAVING PROBLEM.

The difficulties in the way of labor saving in telegraphy may be roughly classed under two heads: Those in connection with commercial messages, and those in connection with press messages. Dealing first with commercial messages, these are short and average about 20 words. Continual stoppages of the mechanism every 20 words are therefore necessary. There is no continuous run, and automatic factory production is not possible. At first sight saving of labor on commercial messages might appear to be easy, but investigation will show that it must of necessity be small. It is impossible to have a machine that will enable one man to do the work of 15 or 20 men, a thing by no means uncommon in the industrial world. A printing telegraph that would merely reduce the amount of labor by half would be a very fine system indeed, and it would effect very nearly the maximum possible labor saving. Take a printing telegraph that can run at 150 words a minute. If it could keep running continuously it would be able to turn out 400 messages an hour. But it has to stop every 20 words or less, and then there are corrections and repetitions and inquiries, also stoppages of the apparatus, breakdowns, line interruptions, pauses for adjustment, and irregular flow of telegraph traffic. All these causes lead to a sad reduction in the output and disappointment to the printing telegraph inventor. If screws never came loose, and metal never broke, and steel never wore out, and human beings never made mistakes, and if telegrams always came flowing in at the uniform rate of four a minute, printing telegraph systems would perform miracles of labor-saving, but they do not. With tape printing the tape has to be cut up and pasted on message forms and the messages signed and timed, the number of words counted and checked, and a note made of the preamble and address. With a page-printing telegraph the loss of time in cutting up tape and pasting it on message forms is saved, but provision has to be made and time allowed for line-feed, column-feed, and page-feed. These delays take place every 20 words or oftener, thereby considerably reducing the saving possible in theory.

The position is entirely different in the case of the stock-ticker and ticker news service. As in the case of the telephone and the telautograph, transmission in the case of the ticker is direct and there are no middlemen. There is no counting of the number of words in messages, no checking the messages, no questions asked from the receiving stations, no envelopes to be addressed, no registered addresses to be looked up, and no delivery of messages. In the case of the ticker practically the whole of the troubles are questions of mechanical maintenance.

PRESS MESSAGES.

Turning now to press despatches, the conditions at the first glance are much more favorable for printing telegraphy, but actual experience shows that the obstacles are much worse than in the case of commercial messages. It is true that press messages are long and therefore very favorable for machine telegraphy and for labor saving. The Murray automatic printer, for instance, can print news despatches easily at the rate of 200 words a minute. That is to say, it enables one man to do the work of six operators writing out messages from Wheatstone tape by pencil or typewriter. The service conditions, however, are so intricate that it is difficult to see how a printing telegraph could do anything more than a fraction of the work, at present at any rate.

The British system of news distribution is divided into the Post Office "News Division" worked by the Wheatstone system, and the leased and private wires rented from the Post Office by the leading British newspapers. London is the great originating and distributing center for news, and it flows out from London all over the United Kingdom. The amount of news that comes up to London from the provinces is comparatively small. Taking first the Government service, in the British "News Division," news distribution is carried on by an elaborate arrangement of Wheatstone circuits, each message being perforated simultaneously on from one to eight tapes by pneumatic perforators, the tapes being then used to transmit press messages over as many as thirty different Wheatstone news wires, many of which have four or more towns strung on them in series. In this way news is distributed all over the United Kingdom at a very rapid rate, and with remarkable economy of labor, as one man can prepare a message for transmission to a hundred or more towns. There are very great difficulties in the way of any printing telegraph coming in and doing this work. In the first place, the news is distributed at a very high speed of from 200 to 300 words per minute. No printing telegraph can work steadily at such a speed on one wire. Also the Murray automatic system, and indeed any other printing telegraph using a special alphabet (not Morse), would require a piece of news to be punched in the Murray alphabet as well as in the Morse, unless the whole news service of Great Britain were handled entirely by the Murray automatic system. Apart from the speed difficulty and the cost of the apparatus, it would take years for a printing telegraph to be installed all over the country. Using it for a few circuits for news would mean double labor in perforating the message in two kinds of tape, one for the Murray and one for the Wheatstone. Other advantages might be great enough to compensate for this extra labor, but the speed of the line would have to be dropped to about 150 words a minute. It was for these reasons that the Murray automatic system was not tried on news work by the British Post Office when it was first brought over to London from New York in 1901. At that time also its speed was only 100 to 120 words a minute. The line speed has now been raised to a

* Paper read before the Institute of Electrical Engineers.

maximum of 184 words (1,104 letters) a minute and 200 words a minute for printing, but this is still insufficient for news requirements in Great Britain. Instead of news work it was put on to commercial work between London and Edinburgh. On that work quite different difficulties were met with. These will be dealt with presently.

A printing telegraph using the Morse alphabet would be more easily employed in the British "News Division," because it would fit in as part of the present news service. With this idea an inventor named Creed applied a differential feed to the Murray automatic printer so as to enable it to print messages from the ordinary Wheatstone Morse perforated tape. He also designed a very ingenious and useful receiving perforator to reproduce Wheatstone tape at the receiving station at a speed of about 150 words a minute. This worked very well, for a time, but owing to its extreme complexity and its high cost, the Post Office only used the Murray-Creed printer to a limited extent. The British Post Office has plenty of wires at night available for transmission of news messages, so that a comparatively low speed, such as 150 words a minute, is not an absolute bar to the use of a printing telegraph; but it is not economical to have too many wires in use, because each wire requires a receiving clerk in constant attendance at each office. For instance, on the Scottish news, if an extra wire is opened a clerk is required in London, Newcastle, Edinburgh, Glasgow, Dundee, and Aberdeen—that is to say, six additional operators for one additional wire. This extra labor would be a considerable offset against any labor saving by a printing telegraph. It is possible that in time the Murray automatic system may come into use for news work. That is the purpose for which it was originally designed; but the prospects are not bright.

In other countries where there is no highly complicated arrangement for news distribution, there is no obstacle to the use of such printing telegraphs as the Murray automatic; but in countries where there is no complicated news-distributing organization there is very little news traffic, and it can be handled easily by the Hughes and other low-speed and therefore cheap instruments. The field for news distribution by rapid printing telegraphs is not large outside of English-speaking countries, and inventors have therefore confined themselves chiefly to the more important field of ordinary commercial telegrams.

Another difficulty about news work is that in London and other large centers of population at least twelve copies are required of press messages for various newspapers. It puts a serious strain on any typewriter to make twelve copies continuously for long periods of time at a high speed. Rotary mimeographs and hectographs get over the difficulty in New York, and there is no reason why they should not do equally well in London.

As an illustration of the perfection of British news distribution, it may be mentioned that the British Post Office has successfully transmitted news at the rate of from 250 to 300 words a minute on a Wheatstone circuit from London, feeding Newcastle, Edinburgh, Glasgow, Dundee, and Aberdeen. In cases where a series of towns are strung on one wire in this way all the messages are sent through and each town picks out what it wants without asking any questions or interrupting the flow of news on the wire. In cases like this, and there are dozens of such circuits in the British News Division, a printing telegraph is at a grave disadvantage. A system worked in this way must not break down, and the high-speed printing telegraph that will not break down occasionally has not yet been invented. If one of the stations breaks down, the messages lost to that station must be repeated to all the five or more stations of the circuit. This involves delay and waste of labor, as each station will have four or five men, or even more, in attendance. Large stations will have twenty or more to write up the messages from the Wheatstone tape.

NEWSPAPER PRIVATE WIRES.

In the case of the private wires rented from the Post Office by British newspapers, the conditions that exist are even worse from a printing telegraph point of view. High-speed printing telegraphs are of necessity complicated and require good mechanical skill to keep them in order. All telegraph offices of any importance have several skilled mechanics to keep the telegraph apparatus in order, but newspapers have none. They have skilled engineers accustomed to large machinery, but small and complicated instruments are quite out of their line. That fact in itself is a most serious difficulty. It means that a skilled mechanic with an assistant and a small workshop would have to be installed. The question of speed also is just as serious with newspapers as with the Post Office. Take, for instance, a great provincial daily paper like the *Glasgow Herald*. Every night it sends from 30,000 to 40,000 words (about thirty columns) from its London office in Fleet Street to its Glasgow office 400 miles away. The great bulk of this extraordinary mass of news is sent over the *Glasgow Herald* private wire between 5 P. M. and midnight, and the conditions are such that it is absolutely imperative to have a speed of transmission over the line of not less than 250 words a minute (1,500 letters a minute) and preferably 300, especially as the night advances and the time approaches for going to press. Even with such high speeds it is occasionally necessary for the *Glasgow Herald* to send some of its news over the Post Office wires. At present the work is done by the Wheatstone system, and there is a staff of 6 to 8 operators in London, who punch the news in the form of perforated tape, and it runs through the Wheatstone transmitter at 200 to 300 words a minute, coming out in the Glasgow office of the *Herald* as dots and dashes on a tape, which is then copied out by a staff of 8 to 10 men. It is not apparent how any printing telegraph can meet such requirements as those of the *Glasgow Herald*. The writer tried it with the Murray automatic systems, but the utmost that he could achieve was 184 words a minute, and even this was with very fine adjustment, much too fine for practical work; 150 words a minute was practical, but it was too slow. Also the *Glasgow Herald* lays itself out especially for giving commercial news, and sends through from London every night several columns of stock and market reports. These are full of intricate figures, and a special system is adopted. There are printed sheets in the London and Glasgow offices of the *Herald* containing all the stocks and shares ordinarily quoted on the Stock Exchange. A letter of the alphabet is used for each stock or share, and they are arranged into groups distinguished by the names of colors, thus: Red *a*, *b*, *c*, etc.; blue *a*, *b*, *c*, etc.; and they are telegraphed thus: Red *a* 2 5/16 7/16, *c* 1 15/16, *d* 3½, etc.; green *a* 110-12, *b* 13¼, *c* 8 19/32, etc. Several columns of this have to be sent through without correction or revision of any kind, and there must be no mistakes. Under the present system mistakes are few. These prices are dropped into their proper places on the printed sheets in Glasgow by the operators who transcribe the Wheatstone tape. A printing telegraph that can do such work at 250 words a minute will take a lot of inventing. Less serious troubles are to be found in the fact that mistakes show up badly in the typewritten pages produced by printing telegraphs and make the sub-editors uneasy about the accuracy of the messages. In the case of the Wheatstone the transcribes correct the errors as they proceed, and they write out clean "copy." The sub-editors, seeing no mistakes, remain in happy ignorance of the frailty of telegraph lines and of human operators, and the editorial mind is at ease. News messages are also telegraphed with many contracted words. This saves time, but the contractors look bad in a typewritten message. When written or typewritten by hand, the contracted words are written out in full. Here is an actual sample of a *Herald* message as it came through and was printed on the Murray automatic:

"SIR W BOBSON SD T GOVT CD NT ACCEPT T AMDT WH WD STRIKE AT T ROOT O T DUTY."

"MR. LLOYD GEORGE SD TT TO AVOID ANY AMBIGUITY HE WD MOVE N AMDT WH WD MEET T POINT RAISED BY MR HILL."

The difficulties met with in connection with the *Glasgow Herald* private wire apply also in the case of other great British newspapers, such, for instance, as the *Daily Mail*, Manchester and Paris editions. These newspapers are all anxious to get some printing telegraph that will meet their requirements, but they are still waiting.

In spite of the great difficulties in the way of using printing telegraphs for news work it would be taking too pessimistic a view to say that printing telegraphs cannot be used for press despatches. They can be and they are so used. In Germany and France, for instance, where the newspaper telegraph traffic is small, all the press messages are sent over the Hughes and Baudot printing telegraphs, and even in Great Britain printing telegraphs will in time make their way for news work; but it will be a very slow progress and very costly. The apparatus will have to be faultlessly made and well-trained men employed to run it. There will probably be a saving of time, but the saving of labor will not be great.

(To be continued.)

Wireless Telegraphy in the Kongo

By Vice Consul General John W. Dye, Boma, Belgian Kongo, Africa.

ON February 4th, 1911, a wireless-telegraphy expedition left Antwerp, Belgium, on the "Elisabethville" for the Kongo. This expedition was organized by M. Goldsmith, of Brussels, for the King of Belgium, who has allotted for the purpose part of a fund of 3,300,000 francs ($636,900) to be used each year for the improvement of the Kongo.

The purpose of the expedition is to erect several experimental wireless stations and test the practicability of establishing wireless communication with Europe and extending the system throughout the territory of the Kongo. It is believed that wireless will be better suited to the conditions of this vast country than the wire system, on account of the great stretches of jungle and marsh, where wiring is extremely difficult, and on account of the ravages of storms and wild beasts, especially of elephants, who seem to delight in pushing over the poles.

The expedition consists of six men, representing two different companies who are competing for the contract for the complete installation of wireless in the Kongo. These companies are the Telefunken of Berlin and the Radio-Telegraphie of Paris. The former system has now been installed at Boma, about 55 miles up the Kongo River, and the Radio-Telegraphie system at Banana, at the mouth of the Kongo. Two more stations are to be installed by the Telefunken, one at Leopoldville, about 220 miles up the river, and the other at St. Paul de Loanda, the capital of the Portuguese Province of Angola, about 200 miles south of the mouth of the Kongo. The stations at Boma and Banana are at the present time in operation and have succeeded in establishing communication with each other and with vessels at considerable distances at sea. Within two months it is expected that regular communication will be established between all four stations. When this is accomplished it will mean a great saving in the time of communication between America and the Kongo.

At present it takes anywhere from 3 to 15 days for a message to go one way between Boma and Washington. This is on account of the circuitous and irregular journey the message must travel. A message started at Boma is transmitted by wire to Leopoldville, 165 miles farther up the Kongo River; from there it goes as best it can, by wire when the connections are not destroyed by storms or elephants, and by foot messengers when they are, to Libreville, on the coast of the French Kongo, and is then passed on via St. Vincent and the Azores to America. When communication is established between Boma and St. Paul de Loanda the time will be cut down to about two or three days, as St. Paul has continuous cable connections with America via St. Vincent.

It is interesting to note that the "Elisabethville" on the voyage noted above carried the first steamship wireless installation to the Kongo. The system used on the "Elisabethville" is the Marconi, and for the first two trips was in charge of an expert operator, sent especially to study the conditions in the Tropics. He reports that atmospheric electricity by night and the effect of the sun's rays at certain times by day make long-distance communication impossible in the Tropics, but that there are times, notably at about 5 or 6 A. M., when these disturbances are at a minimum and long-distance messages can be received. A few years ago it was considered impossible to use wireless in the Tropics, but now, with perfected instruments, we may soon hear of man's latest means of communication serving in the wildest and least known parts of the globe.—*Daily Consular and Trade Reports.*

What It Cost to Develop the Turbine

IN his Rede lecture, which was delivered last June before a large audience at Cambridge, Hon. C. A. Parsons told some of his trials and tribulations in endeavoring to produce the steam turbine. He said that about $120,000 had been spent on the investigation of the problem of marine propulsion by turbines before an order was received.

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